UNCLASSIFIED

Department of Defense FY 1998/1999 Biennial Budget Estimates
February 1997

RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSE-WIDE
Volume 1 - Defense Advanced Research Projects Agency

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Defense Advanced Research Projects Agcy
FY 1998/1999 R D T & E Program

Exhibit R-1

Appropriation: 0400 D Research Development Test & Eval Defwide

Date: FEB 1997

Line No	Program Element Number	Item	Act	FY 1996	FY 1997	FY 1998	FY 1999	Sec
				Thousands of Dollars				
2	0601101E	Defense Research Sciences	1	76,459	90,701	76,009	80,936	U
	Basic Research			76,459	90,701	76,009	80,936	
7	0602110E	Next Generation Internet	2			40,000	40,000	U
13	0602301E	Computing Systems and Communications Technology	2	361,528	314,969	341,752	371,471	U
14	0602383E	Biological Warfare Defense	2			61,600	61,800	U
16	0602702E	Tactical Technology	2	120,440	121,520	155 329	177,995	U
17	0602708E	Integrated Command and Control Technology	2	44,395	59,672	37,000	40,000	U
18	0602712E	Materials and Electronics Technology	2	227,848	213,843	192,192	236,730	U
	Applied Research			754,211	710,004	827 873	927,996	
31	0603226E	Experimental Evaluation of Major Innovative Technologies	3	580,359				U
34	0603569E	Advanced Submarine Technology	3	30,797				U
35	0603570E	Defense Reinvestment	3	177,852				U
46	0603739E	Advanced Electronics Technologies	3	389,610	360,288	277,044	282,668	U
47	0603744E	Advanced Simulation	3	4,809				U
48	0603745E	Semiconductor Manufacturing Technology	3	85,014				U
49	0603746E	Maritime Technology	3	46,351	49,021	37,408	12,592	U
50	0603747E	Electric Vehicles	3	14,694	14,707			U
55	0603760E	Command, Control and Communications Systems	3		102,996	163,800	172,600	U
56	0603761E	Communication and Simulation Technology	3		127,080	75,938	72,114	U

Defense Advanced Research Projects Agcy
FY 1998/1999 R D T & E Program

Exhibit R-1

Appropriation: 0400 D Research Development Test & Eval Defwide

Date: FEB 1997

Line No	Program Element Number	Item	Act	FY 1996	FY 1997	FY 1998	FY 1999	Sec
				Thousands of Dollars				
57	0603762E	Sensor and Guidance Technology	3		108,360	166,855	200,582	U
58	0603763E	Marine Technology	3		40,976	69,143	88,788	U
59	0603764E	Land Warfare Technology	3		63,222	82,580	96,898	U
60	0603765E	Classified DARPA Programs	3		178,040	134,977	65,500	U
61	0603800E	Joint Strike Fighter (JSF) - Dem/Val	3	28,917	72,865	23,900		U
62	0603805E	Dual Use Applications Programs	3		181,184	225,000	225,000	U
	Advanced Technology Development			1,358,403	1,298,739	1,256,645	1,216,742	
99	0605114E	BLACK LIGHT	6	4,623	4,638	4,683	5,000	U
107	0605502E	Small Business Innovative Research	6	42,390				U
113	0605898E	Management Headquarters (Research and Development	6	33,116	36,354	39,193	41,260	U
	RDT&E Management Support			80,129	40,992	43,876	46,260	
Total	Defense Advanced Research Projects Agcy			2,269,202	2,140,436	2,204 403	2,271,934	

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1997

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 1 Basic Research	Defense Research Sciences, PE 0601101E, R-1 #2

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Research Sciences	**76,459**	**90,701**	**76,009**	**80,936**	**74,000**	**76,886**	**76,286**	**79,286**	**Continuing**	**Continuing**
Information Sciences CCS-02	22,103	28,419	19,005	18,900	20,900	20,400	23,700	20,700	Continuing	Continuing
Electronic Sciences ES-01	37,216	51,097	42,004	44,345	33,478	36,533	31,533	37,533	Continuing	Continuing
Materials Sciences MS-01	17,140	11,185	15,000	17,691	19,622	19,953	21,053	21,053	Continuing	Continuing

(U) **Mission Description**: The Defense Research Sciences program element is budgeted in the Basic Research Budget Activity because it provides the technical foundation for long-term improvements through the discovery of new phenomena and the exploration of the potential of such phenomena for military, national security and commercial applications. It supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic and materials sciences.

(U) The Information Sciences project supports basic scientific study and experimentation in software technology, intelligent systems technology, human-computer interaction technology, and varied aspects of high performance computing.

(U) The Electronic Sciences project explores and demonstrates electronic and optoelectronic devices, circuits, and processing concepts that will provide: (1) new technical options for meeting the information gathering, transmission and processing required to maintain near real-time knowledge of the enemy, and the ability to communicate decisions based on that knowledge to all forces in near-real time; and (2) a substantial increase in performance and cost reduction of military systems providing these capabilities.

(U) The Materials Sciences project is concerned with the development of: high power density/high energy density mobile and portable power sources; forward combat casualty care medical technologies; magneto-resistive materials for use in radiation hardened memories and motion sensors; processing and design approaches for nanoscale and/or biomolecular materials and interfaces; medical pathogen countermeasures; and advanced thermoelectric materials for cooling and power generation.

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1997

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 1 Basic Research	Defense Research Sciences, PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Sciences CCS-02	22,103	28,419	19,005	18,900	20,900	20,400	23,700	20,700	Continuing	Continuing

(U) **Mission Description:** This project supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information sciences technology areas such as software foundations and environments, intelligent systems, human computer interface, language technology, microelectronic science, and high performance computing related to long-term national security requirements.

(U) In the area of software technology development, the project objectives are: advanced concept methods and tools to produce high assurance software; language concepts that facilitate the rapid specification and evolution of systems; and techniques to manage shared complex structured data objects in larger heterogeneous, distributed information systems. The intelligent systems technology focus is on advanced techniques for knowledge representation, reasoning, and machine learning, which enables computer understanding of spoken and written language and images. Also included are advanced methods for planning, scheduling, and resource allocation. The focus in the human computer interaction technology area is design methods and enabling technology for more natural interaction between people and computers. Lastly, the high performance computing (HPC) focus is on science-generated concepts and methods for validating and verifying design components, and unique approaches to rapidly develop high performance libraries across multiple HPC architectures.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Developed complex software languages and tools to integrate architecture-level representations of software systems and used these representations for analysis and testing. ($7.6M)
- Enhanced advanced information processing methods in spoken language understanding, written language understanding and automated planning systems. ($3.7M)
- Experimentally evaluated tool kits for interactive, dialogue-based human computer interaction. ($4.2M)
- Refined and began experimental evaluation of design technology to include high performance computational prototyping of systems. ($1.5M)
- Demonstrated utility of scalable libraries for defense tasking; completed basic research effort in scalable operating systems and runtime services; initiated Quorum architecture definition; and demonstrated adaptive computing systems for defense applications. ($2.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project CCS-02

- Developed theoretical classifications of ultrascale computational power. ($1.1M)
- Experimentally evaluated planning and decision aids prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. ($2.0M)

(U) FY 1997 Program:

- Complete the development of the tools and tool kits for development and evaluation of highly interactive, agent and dialogue-based human computer interactions. ($4.7M)
- Advance the capabilities of spoken and written language understanding to solve real-world problems and provide widely usable functionality. ($5.5M)
- Experimentally evaluate design technology for high performance computational prototyping of systems. ($2.2M)
- Experimentally support software evolution by integrating numerous formal and informal information sources in a "hyperweb"; enhance formal notations for software design to include both syntactic and semantic information; and demonstrate multi-language architecture definition and analysis tools. ($5.1M)
- Continue the experimental evaluation of supporting both task and data parallelism for scalable software library technology, and the utility of adaptive computing systems for defense applications. ($1.2M)
- Demonstrate the feasibility of using ULTRASCALE computing techniques to store and retrieve information. ($1.9M)
- Define Quorum architecture and validate findings, and define and validate the next generation of languages and runtime services for supporting parallel task applications. ($1.9M)
- Execute Congressionally directed program for Discovery Center of S&T. ($3.9M)
- Execute the Technology Transfer Pilot Program. ($2.0M)

(U) FY 1998 Program:

- Demonstrate symbolic simulation linked with hardware emulation for complex design technology. ($2.0M)
- Complete the experimental evaluation of design technology for high performance computational prototyping of systems, supporting both task and data parallelism for scalable software library technology. ($1.0M)
- Develop robust spoken and text language technologies with emphasis on affordable dialog grammars and understanding in spite of noise; all technology developed in response to systems experiments focused on critical military needs. ($9.0M)
- Demonstrate a computational model using ULTRASCALE computing techniques. ($5.0M)
- Evaluate the quality of service specifications relative to the Quorum architecture. ($1.1M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project CCS-02

- Demonstrate the languages & runtime services in defense applications, and complete the scalable software library technology demonstration. ($.9M)

(U) FY 1999 Program:

- Develop algorithms to deal with high noise conditions for speech recognition and then evaluate automatic transcription of conversational speech over phone and battlefield radio with a goal of producing a transcript that is human readable. ($7.0M)
- Integrate the multi-attributes of performance, realtime and fault-tolerance for Quorum. ($1.0M)
- Complete this phase of demonstrations, and validations of adaptive computing systems architectures for defense applications. ($2.0M)
- Complete the design technology demonstration effort. ($1.9M)
- Continue the demonstration and validation of ULTRASCALE computing technologies and the scalability of these techniques in defense application. ($6.0)
- Complete validation and demonstrate scalability of languages & runtime services. ($1.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	24.8	23.5	23.0	22.9
Appropriated	22.4	28.4	N/A	N/A
Current Budget	22.1	28.4	19.0	18.9

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects the non-lethal warfare reprogramming source requirement.
FY 1998-99 Reductions reflect realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Sciences ES-01	37,216	51,097	42,004	44,345	33,478	36,533	31,533	37,533	Continuing	Continuing

(U) **Mission Description:** This project seeks to continue the phenomenal progress in microelectronics innovation that has characterized the last decades by exploring and demonstrating electronic and optoelectronic devices, circuits and processing concepts that will: 1) provide new technical options for meeting the information gathering, transmission and processing required to maintain near real-time knowledge of the enemy, and the ability to communicate decisions based on that knowledge to all forces in near real-time, and 2) provide new means for achieving substantial increases in performance and cost reduction of military systems providing these capabilities. Research areas include new electronic and optoelectronic device and circuit concepts, operation of devices at higher frequency and lower power, extension of diode laser operation to new wavelength ranges relevant to military missions, development of uncooled and novel infrared detector materials for night vision and other sensor applications, development of innovative optical and electronic technologies for interconnecting modules in high performance systems, research to realize field portable electronics with reduced power requirements, research addressing affordability and reliability, and research on microelectromechanical systems (MEMS) technology.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Continued investigation of revolutionary approaches to electronics enabled by very small scale devices (nanoelectronics) which operate in a regime where physical phenomenon not important in conventional devices dominate. Demonstrated that compound semiconductor nanoelectronic devices integrated with conventional devices results in significant reductions in chip area required for complex logic functions. Demonstrated the extension of nanoelectronic device designs to silicon-based devices, compatible with future integration with conventional silicon circuits. ($12.3M)
- Demonstrated optical materials and device designs that enable an order of magnitude reduction in threshold current requirements for diode lasers, demonstrated a means for increasing the bandwidth for direct laser modulation by 25%, and demonstrated technology for applying arrays of optical devices for applications in future high-speed, high capacity switching systems. ($4.4M)
- Demonstrated photonic device applications of non-semiconductor thin films doped with optically active ions and explored material technologies for monolithically integrated optoelectronic components. ($3.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project ES-01

- Demonstrated development of high-density integrated electrical/mechanical MEMS along with requisite developments of CAD tools, materials data base, test and characterization methods, and manufacturing processes. ($6.2M)
- Initiated development of uv-blue gallium nitride based LEDs and lasers for high density memory, lightwave countermeasures, convert communications, and warfare. ($5.5M)
- Assessed thermal response characteristics of thin film material for improved sensitivity uncooled infrared detectors. ($.8M)
- Continued low-power electronics program in the area of circuit architecture and power management techniques. Demonstrated Computer Aided Design (CAD) tool for modeling low power circuit designs and estimating circuit static power dissipation. ($5.0M)

(U) FY 1997 Program:

- Continue the ultra-electronics program with emphasis on the following thrusts: combined nanoelectronics and conventional electronics, silicon-based nanoelectronics, chemical self-assembly, and molecular beam epitaxy (MBE) process control and other fabrication techniques. ($11.2M)
- Fabricate small (5 x 5) infrared sensitive arrays as verification of material properties. ($3.2M)
- Develop and demonstrate uv pulsed laser diode operation in the gallium nitride system. Identify relationship between defect density and applicability to military applications such as uv solar blind detectors for missile threat warning. ($7.2M)
- Continue low-power electronics program in the areas of circuit architecture and power management techniques. Demonstrate 256 X 256 pixel sensor with on-chip 10-bit Analog to Digital Converter (ADC). Demonstrate strategies for non-disruptive power supply switching for reduced power consumption. ($5.8M)
- Explore Ultra Photonics efforts leading to advances in the state-of-the-art of Photonic Device Technologies which become the basis for next-generation optoelectronic devices. ($9.0M)
- Establish multi-investigator based centers for research focused on the application of optoelectronic technologies that will enhance the performance of future generations of information processing systems. ($14.7M)

(U) FY 1998 Program:

- Optoelectronics - Demonstrate feasibility of using Gallium Nitride detectors as a UV solar-blind detector for missile threat warning and demonstrate UV/blue lasers operating continuous wave for high density memory and chemical/biological detection. ($10.9M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project ES-01

- Infrared Detector Materials - Determine process for low temperature deposition of thin film uncooled materials. ($3.0M)
- Ultra-Electronics - Demonstrate feasibility of combining a resonant tunneling device (RTD) with conventional devices, silicon based quantum metal oxide semiconductor (MOS) technology, and simple quantum cellular automatic logic circuits using silicon and silicon germanium structures. ($11.6M)
- Ultra-Photonics- Demonstrate practical means for implementing high speed optical buffer memories and signal address recognition based on coherent all-optical (photon-echo) technology. Demonstrate the utility of low cost silicon electronic devices doped with optically active elements (such as Erbium) for applications that are now the exclusive domain of more expensive compound semiconductor devices or glassy materials. ($10.6M)
- Low Power Electronics - Complete low-power electronics programs in the areas of circuit architecture and power management techniques. Demonstrate 256 x 256 pixel image sensor with on-chip 10-bit Analog-Digital Converter. ($5.9M)

(U) <u>FY 1999 Program</u>:

- Infrared Detector Materials - Establish feasibility of new uncooled detector structures, including micromachined arrays, thin film ferroelectrics and bolometric materials. ($3.0M)
- Ultra Electronics - Demonstrate programmable matched filter operating at gigahertz speed with substantially less power than silicon complimentary metal oxide semiconductor (Si CMOS), completely integrated molecular beam epitaxy (MBE) growth system which realizes closed-loop control of atomic layer growth and quantum device structures. ($4.9M)
- Ultra-Photonics - Identify the device properties limiting performance of vertical cavity lasers and demonstrate methods for controlling their output beam quality. ($7.7M)
- Advanced Microelectronics - Explore new concepts, directed at demonstrating feasibility of radical device and systems architecture concepts. Of particular emphasis will be device concepts in microelectronics and optoelectronics enabled by technology advances in related areas, particularly those in sub 0.1 micron lithography and mixed-technology integration. ($13.7M)
- Integrate promising new elements of ultra-electronics, high power electronics, non-volatile memory and Electro-Magnetic Interference (EMI) electronics to address current thrusts in smaller, lighter, more mobile information systems and highest performance components and systems. ($15.0M)

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1997

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 1 Basic Research

R-1 ITEM NOMENCLATURE
Defense Research Sciences,
PE 0601101E, Project ES-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	42.6	39.7	40.1	34.4
Appropriated	38.3	47.8	N/A	N/A
Current Budget	37.2	51.1	42.0	44.3

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects minor repricing adjustments.
FY 1997 Increase reflects emphasis on emerging technological advances in Ultra-Photonics.
FY 1998-99 Increase reflects program adjustments and realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials Sciences MS-01	17,140	11,185	15,000	17,691	19,622	19,953	21,053	21,053	Continuing	Continuing

(U) **Mission Description**: This project is concerned with the development of: high power density/high energy density mobile and portable power sources; forward combat casualty care medical technologies; technologies for defense against biological warfare agents; magneto-resistive materials for use in radiation hardened memories and motion sensors; advanced thermoelectric materials for cooling and power generation; processing and design approaches for nanoscale and/or biomolecular materials and interfaces; and medical pathogen countermeasures.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Electrochemistry. ($10.3M)
  - Developed and demonstrated a high efficiency fuel reformer for fuel cell applications to process logistic fuel (e.g., DF-2, JP-8).
  - Demonstrated fuel cell operation using either hydrogen or methanol with performance adequate for soldier applications.
  - Tested a novel direct oxidation logistics fuel cell concept.
- Biomedical. ($1.7M)
  - Exploited technology base developments in microelectronics, sensors, communications, imaging and simulation to enhance far-forward combat casualty care.
  - Developed haptic interface for virtual environments and holographic display for virtual images in simulation.
- Biological Warfare (BW) Defense. ($3.2M)
  - Continued the development of Up-Converting Phosphor technology and antibody deposition on chips for real-time BW sensing.
  - Demonstrated the feasibility (in the laboratory) of using modified red blood cells to eliminate pathogens from the blood for the purpose of potential defense against biological weapons.
- Magnetic Materials and Devices. ($1.9M)
  - Demonstrated enhanced magneto-resistance ratio at low magnetic fields for faster response and higher sensitivity of magnetic devices.
  - Evaluated spin transistor and spin tunneling devices for use in sensors and non-volatile memories.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project MS-01

(U) FY 1997 Program:

- Electrochemistry. ($8.2M)
  - Develop and test a thermally integrated fuel cell stack and reformer which operates on logistics fuel.
  - Demonstrate direct oxidation, liquid-feed methanol fuel cell stack operation with performance adequate for soldier applications.
- Biomedical. ($1.7M)
  - Demonstrate simulated tissue providing physiologic response to haptic input.
- Magnetic Materials and Devices. ($1.3M)
  - Fully characterize spin transistor and other spin polarized transport devices for use in ultra-high density memory applications.

(U) FY 1998 Program:

- Electrochemistry. ($9.5M)
  - Construct and test a logistics fueled fuel cell power plant for mobile electric power applications.
  - Begin component and system study/demonstration of a direct oxidation fuel cell for replacement of military standard batteries.
  - Explore alternative sources of energy for portable power applications.
  - Develop and demonstrate thermoelectric and thermophotovoltaic materials with significantly improved performance.
- Nanoscale/Biomolecular Materials. ($1.5M)
  - Exploit recent advances in materials design and processing to demonstrate nanostructural control of materials properties with an emphasis on emulating the complex microstructure and scale of biological materials.
- Pathogen Countermeasures. ($2.0M)
  - Determine one or more mechanisms a stem cell could use to link detection of a pathogen to the production by the cell of vaccines and/or therapeutics.
- Thermoelectric Materials. ($2.0M)
  - Demonstrate materials with a factor of two increase in thermoelectric figure of merit.

(U) FY 1999 Program:

- Portable Power. ($10.7M)
  - Optimize catalysts, polymeric membranes, and separator plates for high energy density fuel cell operation.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 1 Basic Research	R-1 ITEM NOMENCLATURE Defense Research Sciences, PE 0601101E, Project MS-01

- Brassboard testing of compact, high performance energy sources for portable power applications.
- Demonstrate novel thermoelectric and thermophotovoltaic power generation devices based on advanced materials.

• Nanoscale/Biomolecular Materials. ($2.0M)
- Demonstrate the applicability of nanostructural and/or biomolecular materials in defense applications such as armor, high strength fibers, or coatings.

• Pathogen Countermeasures. ($3.0M)
- Develop understanding of disease-causing (virulence) factors in pathogens of concern to DoD.

• Thermoelectric Materials. ($2.0M)
- Develop thin film cooler utilizing quantum well structures.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	22.4	11.7	11.5	18.7
Appropriated	18.2	11.2	N/A	N/A
Current Budget	17.2	11.2	15.0	17.7

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia supplemental rescissions and the non-lethal warfare reprogramming.
FY 1998 Increase reflects new efforts in nanoscale/biomolecular materials and thermoelectric materials.
FY 1999 Decrease reflects minor program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Next Generation Internet, PE 0602110E, R-1 #7

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Next Generation Internet NGI-01	0	0	40,000	40,000	40,000	0	0	0	0	N/A

(U) **Mission Description:** The Next Generation Internet (NGI) is an Administration initiative that has three goals: (1) connect universities and national laboratories with high speed networks that are 100 - 1000 times faster than today's Internet; (2) promote experimentation with the next generation of networking technologies; and (3) demonstrate new applications that meet important national goals and missions. The principal agencies involved in this initiative are DARPA, NSF, DOE, NIST and NASA. These agencies will share in funding this research and development effort at $100 million from FY 1998 through FY 2000. The DARPA activity will be aimed at part of the first goal (ultra-high performance connectivity). DARPA will demonstrate end-to-end network connectivity at 1+ gigabits-per-second for 10 of NGI sites and applications. These applications will be the drivers of the properties of very high speed networks to stress the network hardware, software, and products to determine their true characteristics and limitations. The technologies to be addressed include multi-gigabit broadband networks, guaranteed quality of service mechanisms, and integrated network management. These technologies will be demonstrated in a NGI developed testbed environment.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program: N/A

(U) FY 1998 Program:

- Develop, design and initiate building the NGI testbed. ($5.0M)
- Create ultra high bandwith Wavelength Division Multiplier (WDM) connections for Next Generation Internet (NGI) testbed (Supernet). ($15.0M)
- Define quality of service architecture and implement initial operating system kernel for the Supernet testbed. ($15.0M)
- Define 10 gigabit-per-second optical switching transmission protocols and network and resource management strategy. ($5.0M)

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Next Generation Internet,
PE 0602110E, Project NGI-01

(U) FY 1999 Program:

- Implement 10 gigabit-per-second, multi wave optically switched WDM technology in NGI testbed. ($5.0M)
- Implement an alpha-level prototype high speed optical switch and protocol structure. ($15.0M)
- Expand testbed to DoD laboratories and to 10 gigabit-per-second links. ($5.0M)
- Implement prototype network management system. ($10.0M)
- Define application program interfaces (api's) for information management and collaborative applications. ($5.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0	0
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0	0	40.0	40.0

(U) **Change Summary Explanation**:

FY 1998-1999 Increase reflects establishment of the administration's "Next Generation Internet" initiative to connect universities and national labs with high-speed networks that are faster than today's internet.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology,
PE 0602301E, R-1 #13

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Computing Systems and Communications Technology	**361,528**	**314,969**	**341,752**	**371,471**	**405,557**	**461,572**	**499,781**	**515,964**	**Continuing**	**Continuing**
JASON ST-01	1,000	1,170	1,190	1,200	1,200	1,200	1,200	1,200	Continuing	Continuing
Intelligent Systems & Software ST-11	91,005	88,686	105,512	102,981	110,256	127,007	143,007	147,007	Continuing	Continuing
High Performance Computing ST-19	189,323	173,999	169,629	200,981	213,183	236,891	233,551	241,329	Continuing	Continuing
Software Engineering Technology ST-22	26,307	16,461	19,609	20,196	20,200	20,200	20,200	20,200	Continuing	Continuing
Monitoring Technologies ST-23	27,759	0	0	0	0	0	0	0	0	N/A
Information Survivability ST-24	26,134	34,653	45,812	46,113	50,115	55,046	60,654	65,000	Continuing	Continuing
Adaptive Computing ST-25	0	0	0	0	10,603	21,288	41,228	41,228	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because it funds projects directed toward the application of advanced, innovative computing systems and communications technologies.

(U) The largest project funds DARPA's leadership of the Federal High Performance Computing and Communications Initiative that is developing technologies that will lead to successive generations of more secure, higher performance, and more cost-effective scalable systems that are critical to defense operations and federal needs.

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(U) The efforts funded in the Intelligent Systems and Software project focus on the development of new information processing technology concepts that lead to fundamentally new software and intelligent system capabilities. Emphases are in intelligent systems including autonomous systems, interactive problem solving, intelligent integration of information, software development, and manufacturing automation and design engineering.

(U) The Software Engineering Technology project supports the Software Engineering Institute (SEI) that works to transition state-of-the-art technology, and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems.

(U) The Information Survivability project develops the technology base underlying the solutions to protecting DoD's mission-critical information systems against attack upon or through the supporting infrastructure. These technologies lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites and to high-performance computing technologies.

(U) The JASON Group supports studies for the national security community.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
JASON ST-01	1,000	1,170	1,190	1,200	1,200	1,200	1,200	1,200	Continuing	Continuing

(U) **Mission Description:** This project supports the JASONs, an independent group of distinguished scientists and technical researchers that provides analysis of critical National Security issues. JASON membership is carefully balanced to provide a wide spectrum of scientific expertise and technical analysis in theoretical and experimental physics, materials, information sciences, and other allied disciplines. The JASON process ensures senior government leaders have the full range of U.S. academic expertise available on issues critical to National Security involving classified and unclassified information.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Continued studies in: Nuclear and chemical weapons proliferation, precision strike weapons, global surveillance and communications; counter drug surveillance techniques; shallow water ASW; advanced signal processing; and counter terrorism.

(U) FY 1997 Program:

- Continue studies in: Counter proliferation of chemical and biological weapons; precision deep strike weapons, battlefield information systems, battlefield planning and control, law enforcement surveillance techniques; land mine detection; advanced sensor technologies; global surveillance and intelligence; and counter terrorism.

(U) FY 1998 Program:

- Continue studies of interest to DoD in multiple disciplines such as: Counter proliferation of chemical and biological weapons; precision deep strike weapons, battlefield information systems, battlefield planning and control, land mine detection; advanced sensor technologies; global surveillance and intelligence; and counter terrorism.

(U) FY 1999 Program:

- Continue studies of interest to DoD.

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R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology,
PE 0602301E, Project ST-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	1.2	1.2	1.2	1.2
Appropriated	1.2	1.2	N/A	N/A
Current Budget	1.0	1.2	1.2	1.2

(U) **Change Summary Explanation**:

FY 1996 Reduction reflects reprogramming to SBIR program element.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Intelligent Systems and Software ST-11	91,005	88,686	105,512	102,981	110,256	127,007	143,007	147,007	Continuing	Continuing

(U) **Mission Description**: This project develops new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software systems supporting computer and software intensive defense systems. Major areas of technical emphasis are: (a) intelligent systems (artificial intelligence) including autonomous systems, image understanding, intelligent integration of information from heterogeneous sources, and interactive problem solving, planning, scheduling, and decision analysis; (b) software development technology including languages, algorithms, data and object bases, domain specific software architectures, software prototype technology, software design tools, software reuse, and advanced software engineering environments; (c) manufacturing automation and design engineering, including the development of advanced software systems which support sharing of engineering knowledge, advanced product and process design representations, integrated product and process design, software tools for design process management, manufacturing process planning, manufacturing process control and demonstrations; (d) Text Video Speech (TVS) technology focusing on the integration and application of emerging language understanding technology for both C4I and Intelligence community needs; and (e) organizing resources to obtain access to multiple systems and decision aids that provide logistical information when and where it is needed.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Demonstrated and evaluated advanced reconnaissance, surveillance, and target acquisition algorithms on unmanned ground vehicle; installed baseline RADIUS Site Monitoring System at National Photographic Interpretation Center; delivered first version image understanding environment. ($10.9M)
- Experimentally evaluated implementations for human-aided machine language translation, document understanding, and robust speech understanding in adverse acoustic conditions. ($13.4M)
- Experimentally evaluated implementations of real-time planning and control algorithms. ($1.8M)
- Evaluated knowledge-based planning and decision aids to support the rapid construction of multiple crisis action plans in an operational exercise. ($9.4M)

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- Developed new techniques for intelligently locating, filtering, accessing, and integrating information from disparate, heterogenous, distributed information sources and demonstrated the use of those techniques in accessing information for air campaign planners, logistics planners, satellite imagery users, weapon system engineers, and others. ($11.7M)
- Developed an initial library of knowledge base components to support the creation and maintenance of High Performance Knowledge Bases in military command and control. ($1.5M)
- Developed planning and control algorithms for tasking multiple homogeneous assets in support of small unit operations. ($3.5M)
- Integrated Artificial Intelligence based research technologies with numerical simulations and CAD Models, and demonstrated a three fold reduction in trade-off analysis and collaborative design optimization. ($11.1M)
- Continued the human computer interaction heterogenous testbed product development and insertion. Tested, evaluated, and demonstrated enhancements to the user community. ($6.9M)
- Defined consensus Architecture Description Language and Interactive Architecture Synthesis Tools and initiated development of tools for complex system design. ($4.1M)
- Developed and demonstrated multi-echelon, collaborative logistical support tools that integrate planning, execution, monitoring and decisions support systems to achieve real time logistical reallocation and redeployments within and between commands. ($4.1M)
- Supported software initiatives at the National Applied Software Engineering Center (NASEC), Johnstown. ($9.6M)
- Supported Software Productivity Consortium. ($3.0M)

(U) <u>FY 1997 Program</u>:

- Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities. ($6.3M)
- Experimentally evaluate methods for building information detection filters from text, and baseline topic concept recognition from radio news broadcasts. ($2.7M)
- Evaluate distributed design tools and demonstrate multi-agent systems for capture of collaborative design history. ($12.8M)
- Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding. ($5.2M)
- Develop performance enhancements in planning/scheduling algorithms and advanced architectures planning and decision aids systems. ($7.5M)

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- Extend Architecture Description Language for complex systems to include performance and context information. ($5.5M)
- Initial implementation of distributed dynamic language and real-time dynamic language. ($4.5M)
- Initial web-structure configuration management capability. ($3.9M)
- Support software initiatives at the NASEC, Johnstown. ($9.8M)
- Develop new image understanding technologies for image exploitation, automatic population of geospatial databases, and video surveillance and monitoring to enhance battlefield awareness. ($6.0M)
- Perform university research toward development of automated target recognition technologies that operate effectively under difficult circumstances involving obscuration, camouflage, and urban settings. ($1.1M)
- Developed and demonstrated, in the Intelligent Integration of Information area, techniques to integrate disparate data sources for logistics planning, command and control, and battlefield awareness. ($11.3M)
- Developed a library of knowledge base components and a suite of interoperable editing tools to support the creation and maintenance of High Performance Knowledge Bases in battlefield awareness and military command and control. ($7.8M)
- Develop site-monitoring technology and testbed for evaluating utility of automated tools for image analysts. ($1.8M)
- Reuse Technology Adoption Program (RTAP). ($2.5M)

(U) <u>FY 1998 Program</u>:

- Integrate selected RaDEO design computation tools to demonstrate robust multi-disciplinary design. Demonstrate a 5X reduction in early design trade-off time by combining qualitative and quantitative models. ($5.5M)
- Develop initial prototypes for multi-language text extraction and audio transcription where performance is baselined against that of human operators. ($6.7M)
- Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities. ($11.4M)
- Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding. ($5.7M)
- Develop, in the Intelligent Integration of Information area, tools and techniques to enable the rapid construction of information fusion, aggregation, and summarization software to filter, access, and integrate information from 100's of disparate, heterogenous, distributed data sources. ($9.5M)

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- Integrate human-in-the-loop and automated planning and decision aids techniques for managing military command and control processes in quickly-changing operational settings; demonstrate capabilities to generate, assess, and select among multiple alternative plans in time currently required to generate one plan. ($10.4M)
- Demonstrate use of web to integrate rationale, system models and implementation. ($4.0M)
- Initial demonstration of ability to incrementally reanalyze a system using propagation bounding. ($8.0M)
- Release of real-time dynamic language to demo team. ($5.0M)
- Support software initiatives at the NASEC, Johnstown. ($10.0M)
- Develop, demonstrate, and evaluate image understanding technologies for image exploitation, automatic population of geospatial database, video surveillance and monitoring, and automatic target recognition to enhance battlefield awareness. ($11.6M)
- Use unified knowledge representations in tools for focused knowledge acquisition, extend learning methods, and add new, high-performance, problem-solving methods to the High Performance Knowledge Base library. ($7.7M)
- Continue Computer Aided Education and Training Instruction (CAETI) effort to enhance ongoing collaborative learning environments; evaluate collaborative virtual workspaces; and complete integrated tools architecture for DoD testbeds. ($10.0M)

(U) <u>FY 1999 Program</u>:

- Extend Architecture Description Language for complex systems to include performance and context information. ($5.0M)
- Linkage of design rationale to system modeling artifacts in design web. ($5.0M)
- Demonstration of web-based environment that combines design and analysis on realistic examples. ($5.0M)
- Develop language comprehension technology to provide extraction of content and production of summary information focused on information access, manipulation and creation tasks in order to demonstrate improved readiness for military planning and situation awareness. ($12.0M)
- Develop and demonstrate fully automatic algorithms to determine the structure of radio and TV news broadcasts in several languages allowing military planners and intelligence analysts to detect and tract emerging topics. ($7.8M)
- Demonstrate a 2X reduction in detailed design by integrating Design Web and Computational Tools made for multi-disciplinary optimization. ($2.7M)
- Integrate most successful new image understanding and automatic target recognition technologies into feasibility demonstrations for UAV image and exploitation, synthetic environments, and video surveillance.

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Demonstrate and evaluate impact of embedded image understanding technologies on battlefield awareness. ($14.0M)

- Demonstrate and transition Intelligent Integration of Information tools and techniques to enable the rapid construction of large scale information associates to filter, access, and integrate information from 100's of disparate, heterogenous data sources. ($12.0M)
- Demonstrate and evaluate impact of embedded image understanding technologies on battlefield awareness. ($14.0M)
- Develop adversarial planning tools for countering intelligent foes. Continue close interaction with Rome Labs. ($10.0M)
- Develop and demonstrate a situation assessment knowledge base through reuse of knowledge base components. ($10.0M)
- Demonstrate commanders decision tools for planning and control in highly stressed operations environments. ($5.5M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	95.0	98.4	107.5	112.8
Appropriated	95.8	90.1	N/A	N/A
Current Budget	91.0	88.7	105.5	103.0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects below threshold reprogramming for the High Performance Knowledge Base Program ($+1.9 million), reprogramming to the SBIR program element, and inflation savings.
FY 1997 Decrease reflects minor repricing.
FY 1997-99 Decreases reflect realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
High Performance Computing ST-19	189,323	174,239	169,629	200,981	213,183	236,891	233,551	241,329	Continuing	Continuing

(U) **Mission Description:** This project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future defense and federal needs. These technologies lead to successive generations of more secure, higher performance, and more cost-effective scalable systems, associated software technologies, advanced mobile information technology and prototype experimental applications critical to defense operations. The High Performance Computing program is comprised of the following components:

- Global Mobile Information Systems effort deals with the activities required for defense-based mobile systems, including modal architectures, adaptive extensions, changing resources and robust mobile services.
- The Systems Environments component develops scalable software which is tailored toward easing the use of systems by application programmers. This includes languages, run-time services, scalable software library technologies, and experimental applications.
- The Networking component develops high performance networking technologies and associated network management capabilities. Research is coordinated with network technology and Service deployments made by DoD, NASA, and other federal agencies.
- The Scalable Systems and Software component develops software and hardware technologies leading to a secure scalable computing and communications technology base for systems configured over a wide performance range, from mobile handheld devices to desktop workstations to the largest-scale, highest performance systems.
- The Microsystems component develops design tools, environments, and design infrastructure to support the research and development of advanced scalable parallel computing components and embedded computing systems. Microsystems is the incubator and delivery mechanism of future generation defense advanced information systems components. Microsystems is the critical bridge that leverages other DARPA technology in low-power processes, advanced packaging, materials, and electronic componentry to develop the critical architecture and building blocks of the most advanced defense computing and communication systems.
- Defense Technology Integration and Infrastructure combines state-of-the-art computing and information technologies focused on critical defense applications. These include developing embeddable systems based upon scalable technologies, and projects which accelerate technology transition of advanced research to intelligence, command and control, and other major DARPA and DoD programs. Technologies addressed include

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- information management, integration of systems, real-time, multimedia collaboration and visualization and application adaptivity.

(U) Each of the above components of this program will integrate capabilities developed under the Information Survivability initiative (Project ST-24) to satisfy defense requirements for secure systems.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Global Mobile Information Systems. ($14.7M)
  - Developed initial prototype of adaptive extensions; and untethered node hardware/software architectures.
  - Demonstrated design environments supporting simulation and synthesis of wireless systems.
  - Completed the experimental evaluation of the integration of multiple advanced intelligent systems.
- Systems Environments. ($23.0M)
  - Evaluated first generation of fully scalable operating system software and programming environments on small-scale versions of teraops computing systems.
  - Defined second generation of High Performance Fortran with extensions for task parallelism and support for scalable Input/Output (I/O).
  - Demonstrated extensions of portable scalable libraries to incorporate object-oriented technology and a broader set of applications.
  - Enhanced and experimentally evaluated advanced software environment that supports composition tools.
- Networking. ($29.9M)
  - Prototyped networks at greater than 40-gigabit-per-second speed using optical technologies; experimentally validated scalable network protocols at the higher speeds; and integrated secure nomadic computing architecture into existing wide area networks.
  - Deployed reference implementation of protocol-independent, multicast-capable infrastructure as basis for development of advanced services.
  - Demonstrated robust and secure network-level infrastructure protocols to include directory services and resource allocation; and technology for autonomous, node-level network management.
- Scalable Systems and Software. ($37.0M)
  - Demonstrated user-extensible microkernel operating system technology, integrating compiler and run-time

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support services; computing node architectures that dramatically increase internal memory and communications bandwidths; and I/O enhancements to a scalable operating system that overcomes identified bottlenecks leading to significant improvements in throughput.

- Microsystems. ($33.9M)
  - Performed early demonstration of parallel, fully-hierarchical Automatic Test Generation for both combinational and sequential circuits.
  - Demonstrated fault-tolerant and reliability design tools supporting large-scale HPC systems developments; distributed computing architectures based on low-cost, low-latency switching technology; and integrated module-level synthesis capability.
  - Prototyped emulation-enhanced system simulation capabilities for microsystems design.
  - Developed highest performance open interconnect component for embedded defense systems, future demos in various systems, missiles and satellites.
  - Designed message-passing/shared-memory hybrid architecture protocol accelerator component.
- Defense Technology Integration and Infrastructure. ($43.1M)
  - Developed and provided experimental testbed services employing advanced high performance computing technologies for defense users; and prototype distributed, object-oriented architecture for scalable, interoperable, multimedia digital library repositories.
  - Prototyped embedded computing system modules with scalability concepts containing memory hierarchy and power on a single unit of replication.
  - Performed integration tests in key defense applications such as advanced distributed simulation, advanced distributed collaboration, advanced communications and control, and advanced human computer interfaces.
  - Demonstrated first fine-grained high performance embedded and scalable computer system; graphical program environments for embedded systems; prototype toolkits supporting development of applications adaptive to changes in the computing and communication environment; and prototype of information services through a testbed incorporating information management and secure transactions.
  - Demonstrated the integration of multiple real-time systems in a semi-autonomous ground vehicle.
- Metacomputers. ($7.7M)
  - Established a metacomputing center testbed in the National Capital Region.

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(U) FY 1997 Program:

- Global Mobile Information Systems. ($15.6M)
  - Demonstrate location-transparent computing relocation and data access within a mobile application support environment.
  - Develop adaptive networking extensions to Internet services in support of mobility; and prototypes of untethered node architectures for mobile computing.
- Systems Environments. ($17.7M)
  - Enable scalable structural dynamics applications using scalable software library technology for sparse symmetric Eigen problem.
  - Demonstrate experimental, scalable Advanced Distributed Simulation applications enabling STOW-97 to utilize 50,000 entities; and automatic optimization of data movement across the memory hierarchy in distributed shared memory systems using languages and runtime services.
  - Define HPC++ languages and runtime services with extensions for data and task parallel exploitation of concurrency.
- Networking. ($29.3M)
  - Network Engineering.
    - Develop plan for Network Engineering and Management Program, and manage large-scale scalable network engineering technology.
  - High Performance Networking.
    - Demonstrate high performance networking systems for coordinating sets of workstations as a single computing system, and test high-performance subsystem.
  - Active Networks.
    - Define Enhanced Networking Services Architecture for routing, multicast, location aware, and proxy services.
    - Develop definition and protocols of SmartPacket Format, and of Execution Environment.
- Scalable Systems and Software. ($31.9M)
  - Scalable Computing.
    - Demonstrate integration of parallel communication and processing; of scalable, MAGIC-based, system prototype and operational protocols; and performance of distributed shared-memory hardware supporting several commodity processors.

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- Ultrascale Computing.
  * Design ultrascale quantum architecture model that addresses error-correction, computation in a noisy environment, and multispin entanglements; and develop and exercise computing simulator computation model to evaluate parallel behavior and performance structure.
- QUORUM.
  * Define and integrate architecture, and develop quality-of-service specification language.
  * Demonstrate order of magnitude performance improvement of translucent system layers using network-attached secure disks.

• Microsystems. ($32.5M)
- Microsystems Design.
  * Release comprehensive complex system design benchmark suite.
  * Draft specifications for common descriptive format for complex system design hardware verification.
  * Demonstrate multi-site parallel processing design collaboratory; formal methods for early complex system design microprocessor verification; sequential complex system design processor verification; and integrated environment spanning of advanced parallel processing microcomponents.
  * Develop complex system design functional error modeling and test generation.
- Adaptive Computing Systems.
  * Develop 1 million gate standard form factor boards and hybrid system prototypes using configurable component technology; automatic process of template design and integration (for ATR library templates).
  * Demonstrate 10x performance improvement of user-level software on challenge problems.

• Defense Technology Integration and Infrastructure. ($35.1M)
- Prototype Distributed System of Systems.
  * Develop prototype Mediated Link application.
  * Evaluate the experimental Mediated Link on a LAN.
  * Evaluate Phase II feasibility and cost; and complete Phase II Program Plan.
- Information Management.
  * Deploy net-accessible prototype demonstrating vocabulary switching and object categorization; deploy operational prototype with active references to technical literature to licensed institutions.
  * Develop scalable information value framework to characterize prior use of objects; and testbed for electronic deposit, registration and recordation of digital objects.
  * Demonstrate agent architecture for cross-collection search and results fusion.

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- Intelligent Collaboration and Visualization.
  * Develop initial design of collaboration architecture; definition of candidate approaches to represent self-describing objects; and initial specification of evaluation approach and benchmarking of performance measures.
  * Demonstrate multimedia annotation for graphical representations, shown through a collaborative application where a user can attach multimedia comments to objects in a 2-D/3-D graphical space and where collaborating users can review and add to these annotations.

• Embeddable Computing. ($11.9M)
  - Demonstrate first DoD lab coordinated flight technology; 100 gigaops/cu. ft.; and heterogeneous architectures.
  - Integrate support for instrumentation and visualization of real-time operating systems; ability to monitor performance of realtime systems and interact in-situ; and system and application software technologies.
  - Fabricate and test digital signal processing (DSP) chips for advanced vision systems.
  - Develop first prototype accelerator module: Alacron, Westinghouse/ASI for advanced vision systems; signaling technology, Signaling Workshop; and initial set of visualization tools for cpu and memory.

(U) <u>FY 1998 Program</u>:

• Global Mobile Information Systems. ($16.9M)
  - Demonstrate application support services for adapting mobile application support to changing infrastructure resources; and robust, mobile networking based on packet radio algorithms.

• Systems Environments. ($14.7M)
  - Demonstrate order of magnitude reduction in design time with experimental scalable applications; experimental scalable application versions of new iterative solvers for radar cross-section modeling; and languages and runtime services supporting parallel applications such as Advanced Distributed Simulation; and HPC++ languages and runtime services supporting both task and data parallelism.

• Networking ($27.9M)
  - Networking Engineering.
    * Complete and release specification language for network engineering elements and management system.
  - High Performance networking.
    * Demonstrate additional high performance networking systems, and enhanced ATM-switching, high-performance, networking technology.

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    * Test subsystem in a testbed and demonstrate subsystems scalability in a defense application.
  - Active Networks.
    * Implement prototype of Enhanced Networking Services utilizing composable modules.
    * Complete composite protocol prototype implementation of execution environment; of fast compiler for SmartPacket Methods; and of basic switch functions.
    * Initiate operation of wide area Active Network on composite prototype platforms.
- Scalable Systems and Software. ($40.9M)
  - Scalable Computing.
    * Demonstrate highly efficient, parallel nodes; auto-parallelization performance of file I/O from Scalable I/O Consortium; first node-level performance of ultra-low-power systems; performance of novel backplane networks supporting security; and hardware-accelerated, distributed, shared-memory performance on workstation clusters.
  - Ultrascale Computing.
    * Design, model, and assess quantum-to-Si hardware and software interface; and language for expressing amorphous algorithmic computations.
    * Develop tools and mechanisms to build bioelectronic systems.
    * Demonstrate 256-component addressed array of molecular computational mechanisms; and evaluate surface patterning mechanisms for culturing neural components on silicon.
  - QUORUM.
    * Develop quality-of-service negotiation protocols for performance architecture attributes; and adaptive resource discovery protocols.
    * Demonstrate order of magnitude improvement in operating systems/network interface of translucent system; and LAN-based quality-of-service performance assurance for Quorum Prototype #1.
- Microsystems. ($28.7M)
  - Microsystems Design.
    * Develop formal complex system design semantics for common intermediate format and extend arithmetic verification of complex system design to floating point.
    * Verify complex system, in-order execution superscalar processors and automate complex system error modeling and test generation.
    * Demonstrate scalability beyond 128 nodes of parallel design environment; scalable, parallel-processing; and symbolic simulation linked with hardware emulation for complex system design.

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- Adaptive Computing Architectures.
  * Complete architecture designs using configurable component technology for low-power, hybrid, reduced overhead prototypes.
  * Develop high-level language and demonstrate adaptive template matching concept software prototype showing auto runtime remapping.
- Defense Technology Integration and Infrastructure. ($25.5M)
  - Information Management.
    * Develop algorithms to effectively search collections of documents for words used only in restricted senses; and design query and preferences languages incorporating similarity and value filtering.
    * Demonstrate translingual search aids for military type documents in English, Korean and a European language; electronic document management with access controls; statistical co-occurrence techniques for texture classification of images; and semi-automatic generation of metadata.
  - Intelligent Collaboration and Visualization.
    * Develop initial software library of critical collaboration middleware for data sharing, coupling and coordination.
    * Demonstrate the meaning of machine-assisted structuring using an irregular information space; mutually-enhancing views, shown by a collaborative application; and real-time multimedia ad-hoc collaboration
- Embeddable Computing. ($15.0M)
  - Demonstrate missile application technology; in-system, high-speed, reconfigurable advanced vision switches; HPC portable/scalable instantiations of domain-specific tools and middleware; and UUV technology.
  - Develop hard realtime/operating systems with security; systems tools and middleware with adaptive scheduling of tasks; and wrapper generator for encapsulating advanced vision systems.

(U) <u>FY 1999 Program</u>:

- Global Mobile Information Systems. ($16.8M)
  - Demonstrate distributed computing in mobile application support environment; continuous networking mobility between wireless domains; and integrated high data-rate untethered node.
- Systems Environments. ($14.2M)
  - Demonstrate experimental scalable image processing application using DARPA embedded systems platform.
- Networking. ($34.3M)

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- High Performance Networking.
  * Demonstrate interoperable Execution Environments on multiple, high-end workstations for packet formats, languages and protocols.
  * Complete evaluation of high-performance subsystem in a testbed and demonstrate the scalability of subsystems in defense application.
- Networking Engineering.
  * Evaluate prototype robust distributed, large-scale, network engineering management systems in a testbed.
  * Demonstrate reliable service foundation for routing, multicast, and location-aware Enhanced Networking Services on multiple high end workstations.
- Active Networks.
  * Initiate operation of secure Enhanced Networking Services proxies crossing independent administrative domains; of Enhanced Network Services on Active Network Testbed across ~10 sites of ~10 switches each; and of Active Network Testbed across ~10 sites of ~10 switches each using composite protocols.
  * Release initial formal specification and composite protocols of Enhanced Networking Services for critical review.
  * Demonstrate resource protection, security, and survivability functions as defined in goals and composite protocols.

• Scalable Systems and Software. ($47.9M)
- Scalable Computing Systems.
  * Release efficient, high-speed, parallel signaling design scripting tools.
  * Demonstrate 32-port, fault-tolerant switch performance at 2.5 gigibits-per-second/wire signaling rate, ultra low power; and performance of 4 gigibits-per-second/wire backplane switch technology and release designs.
- Ultrascale Computing.
  * Conduct system-level detailed design study of a computation model and design/fabricate/demonstrate testbed prototype of a computation model concept.
  * Demonstrate silicon/neuronal information transfer mechanism; distributed sensor model application on amorphous array with >1,000 elements; and feasibility of DNA computation mechanisms on 64,000 component surface.

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- QUORUM.
  * Integrate multi-attribute quality-of-service specification language architecture.
  * Demonstrate dynamic quality-of-service architecture in LAN; order of magnitude improvement in operating systems/network; fast, multiconstraint, adaptive resource discovery and allocation in LAN environment; and LAN-based, quality-of-service, integrated assurance for Quorum Prototype #2.

• Microsystems. ($32.0M)
  - Microsystems Design.
    * Verify out-of-order execution superscalar processor for complex system.
    * Demonstrate formal complex system design verification techniques; and distributed parallel processing computation with remote visualization.
    * Develop first 21st-century, parallel processing microsystems through distributed approach—prototype environment provides open access.
  - Adaptive Computing Architectures.
    * Debug and validate novel, configurable component technology architectures, and develop ability to auto map 500,000 gates and demonstrate estimators.
    * Demonstrate 100x user-level software performance improvement over commodity microprocessors on challenge problems, and release new algorithm design software environment optimized to leverage adaptive software technology.

• Information Management. ($14.0M)
  - Develop framework for combined text, image and relational interoperation.
  - Demonstrate translingual query by entering English language query and retrieving documents in at least two foreign languages; and semi-automatic topic assignment for unrestricted documents with acceptable accuracy.
  - Validate design of secure repository architecture for digital objects up to 100 megabytes in size.

• Intelligent Collaboration and Visualization. ($16.0M)
  - Develop composition of application-specific and generic collaboration middleware.
  - Demonstrate the meaning of multimedia archiving and review of sessions using video/audio indexing and synopsizing; and interoperable asynchronous collaboration prototype applications among mobile users.

• Prototype Distributed Systems. ($15.8M)
  - Transfer the initial next generation internet technology into a defense specific, distributed operational testbed, and SC-21 prototype for Navy shipboard communications.

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- Evaluate the scalability issues of the prototype system of systems.

• Embeddable Computing. ($10.0M)
- Demonstrate graphics algorithm tools and middleware on a complex system.
- Develop advanced vision system compiler for digit-serial DSP, and vision system FFT/DFT chips, clockless logic.

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	234.6	191.2	192.0	208.2
Appropriated	194.4	175.1	N/A	N/A
Current Budget	189.3	174.0	169.6	201.0

(U) **Change Summary Explanation:**

FY 1996 Decrease reflects Bosnia supplemental rescission ($-3.3 million), JCS reprogramming action ($-.8 million) and below threshold reprogramming for SBIR ($1.0 million).
FY 1997 Decrease reflects program repricing.
FY 1998-99 Decreases reflect program reprioritization.

(U) **Other Program Funding Summary Cost:** N/A

(U) **Schedule Profile:** N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Software Engineering Technology ST-22	26,307	16,461	19,609	20,196	20,200	20,200	20,200	20,200	Continuing	Continuing

(U) **Mission Description:** Software is key to meeting DoD's increasing demand for quality, affordability, and timeliness of national defense systems. There is a critical need to rapidly transition state-of-art technology and best practices to improve the acquisition, engineering, fielding, and evolution of software-intensive DoD systems. This project funds the technology transition activities of the Software Engineering Institute (SEI) at Carnegie Mellon University. The SEI is a DARPA sponsored Federally Funded Research and Development Center (FFRDC). It was established in 1984 as part of the DoD's software initiative to identify high leverage technologies and practices and to establish transition mechanisms that enable technology exploitation by both "in-house" government facilities and the industrial base where the bulk of defense software is produced. The Institute works across government, industry, and academia to: (1) improve current software engineering practice for DoD systems; (2) provide value-added transition of technology to practice; and (3) evaluate and calibrate emerging technologies to determine their potential for improving the evolution of software-intensive DoD systems.

(U) The SEI enables the exploitation of emerging software technology by bringing engineering discipline to software development and evolution. The SEI focuses on software technology areas judged to be of the highest payoff in meeting defense needs. Current focus areas include Trusted Systems and Information Warfare, Software Acquisition Risk Management, Architecture-Centered Software Engineering, and Software Processes and Process Improvement.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Improved practice of software engineering for DoD systems -- validation of Capability Maturity Model (CMM) as a guide to effective software process; education in Personal Software Process to improve performance of individual engineers; a repository of software risk management experience; and creating/modifying guides to the current practice of software reengineering; guidelines for adoption of Computer Aided Software Process (CASE) tools and case studies of product line engineering. ($8.0M)
- Evaluated software technology to facilitate transition -- guide to software architecture description languages; approaches to architecture evaluation and comparison; lessons learned in software technology evaluation; and software process measurement guidebook. ($7.0M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-22

- Technology focus in trusted software and information warfare -- continued operation of Computer Emergency Response Team/Coordination Center (CERT/CC) for network incident responses; SIMPLEX architecture approach to providing safety net for system evolution; quality attribute framework to provide taxonomy for four software quality attributes: safety, performance, dependability, and security. ($2.0M)
- Supported the creation of a software engineering professional structure and broad dissemination of knowledge to the government, industrial, and academic communities. ($3.6M)
- Software managers network effort supported by the development and application of active learning tools for senior level management. ($5.7M)

(U) FY 1997 Program:

- Practice improvement: Integrate and enhance models for software processes, process improvement methods, and analytical capabilities to provide common base for process assessments and improvement analysis. Design and establish repository for DoD software risk management experience that is useful to DoD acquisition managers. ($5.1M)
- Technology evaluation: Expand and improve architecture-centered technologies for product lines and evolutionary systems to develop consensus on guidelines for domain engineering, system reengineering, and open systems. Investigate team approaches to provide improved collaboration capabilities and information dissemination in DoD software development efforts. ($4.6M)
- Trusted software and information warfare: Develop pilot models for assessing information system survivability. Establish techniques for applying architecture-centered technologies to support the representation and analysis of trust attributes. Study effective countermeasures for information warfare against software-intensive systems including: security risk taxonomy and guidelines, security analysis tool kits, and guidelines for the acquisition of trustworthy open systems. ($6.8M)

(U) FY 1998 Program:

- Improve practice of software engineering for DoD systems -- Automate process support capabilities by providing mechanisms that provide interoperability among heterogeneous design and manufacturing environments. ($1.5M)
- Evaluation of software technology to facilitate transition -- Evaluate system reengineering approaches that generate secure "wrappers" around legacy code to guarantee desired system properties. Demonstrate and distribute tools to support design of trustworthy systems by relating requirements, technology, and process descriptions. ($6.0M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-22

- Trusted software and information warfare -- Establish intelligent incident response infrastructure that maintains awareness of current threats and solutions. Provide "immunization" of systems to attack (or other threats) by categorizing the root causes for network security flaws and developing mechanisms to correct these causes. Investigate technology for early analysis of system attributes pertaining to trust based on architectural descriptions of the system. Define and document administrative practices for operating a trustworthy network and distribute on interactive media. ($12.1M)

(U) FY 1999 Program:

- Investigate/develop capabilities for rapid and inexpensive creation of Very High Level Languages (VHLLs) and code generators to attain breakthrough improvements in software productivity and quality. ($3.0M)
- Develop and distribute methods and tools to support prediction of key system properties during system development and preservation during system evolution. ($5.2M)
- Provide tools and techniques to enable rapid adaptation and reconfiguration of systems to ensure survivability in the face of attack. ($3.0M)
- Define effective means for interoperation/integration of heterogeneous system components that are generated from architectural descriptions and account for differences in fidelity and semantics as well as protocols. ($5.0M)
- Establish analysis and test infrastructure for assessing the survivability of software systems that include Commercial Off The Shelf (COTS) products. ($4.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	19.2	18.1	19.6	20.2
Appropriated	35.6	16.5	N/A	N/A
Current Budget	26.3	16.5	19.6	20.2

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects DD-1415 reprogramming of Global Broadcast System ($8.0 million), and below threshold reprogrammings ($1.3 million).

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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DATE February 1997

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Computing Systems and Communications Technology, PE 0602301E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Survivability ST-24	26,134	34,653	45,812	46,113	50,115	55,046	60,654	65,000	Continuing	Continuing

(U) **Mission Description:** This project is developing the technology required to protect DoD's mission-critical information systems against attack upon or through the supporting infrastructure. These technologies will lead to generations of stronger protection, higher performance, and more cost-effective security solutions scalable to several thousand sites and to high performance computing technologies. Technologies developed under this project will be exploited in High Performance Computing (ST-19) and other defense programs to satisfy defense requirements for secure and survivable systems. This program is an expansion of investments in information security made previously in High Performance Computing.

(U) Information Survivability focuses on early prototypes of software and hardware technologies leading to scalable protection for large-scale, heterogeneous systems usable over a wide range of performance in diverse threat environments. High confidence networking technologies will be developed consisting of security mechanisms and value-added security services for integration into network technologies. High confidence computing systems will be developed that provide modular security services and mechanisms, provide high reliability for distributed computations, and allow geographically-separated parts of an organization to interact as if they shared a common security perimeter. This also includes secure and fault-tolerant operating systems, firewalls, and system management tools. Assurance and integration tools will aid the development of high assurance and trusted systems that add expression of modular system structures, networking, and other distributed-system protocols and the ability to reason about their security properties.

(U) Survivability technologies will be developed to mitigate national and defense computing infrastructure vulnerabilities that could be exploited by an information warfare enemy. Intrusion-detection systems will allow attacks on the defense infrastructure to be detected, the damage to be assessed, and appropriate response to be taken. Technologies will be developed to allow crisis-mode operation of critical infrastructure components. Robust networking protocols will be designed to facilitate continuous operations in hostile environments.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Computing Systems and Communications Technology, PE 0602301E, Project ST-24

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- High Confidence Networking. ($8.1M)
  - Demonstrated prototype of secured routing protocols.
  - Partially developed cryptographic applications programming interface (CAPI) for algorithm independence and ease of integration of security into applications.
- High Confidence Computing Systems. ($10.2M)
  - Demonstrated cryptographic-applications programming interface to allow secure applications to be built independent of the cryptography used.
  - Demonstrated a high-assurance microkernel for use in secure operating systems.
- Assurance and Integration. ($3.8M)
  - Began work on dynamic security metrics and evaluation tool for white-box evaluation of security of systems with respect to a threat model.
- Survivability of Large Scale Systems. ($4.0M)
  - Began work on verified robust secure multicast protocols able to tolerate Trojan horses and malicious code.
  - Completed initial intrusion-detection prototype.

(U) FY 1997 Program:

- High Confidence Networking. ($7.9M)
  - Release reference implementation of secure Open Shortest Path First routing protocol.
  - Demonstrate toolkit for production of network intrusion detection software.
- High-Confidence Computing. ($7.7M)
  - Demonstrate verified hybrid group membership protocol for tolerating mixed malicious/benign faults.
  - Demonstrate protocols for end-to-end fault tolerant real-time services on local area network (with embedded).
- Assurance and Integration. ($6.4M)
  - Complete implementation of a small set of security and fault tolerance techniques as wrapper components.
  - Complete a tool for white-box security evaluation with respect to a threat model.
- Survivability for Large Scale Systems. ($10.1M)
  - Demonstrate technology for continued operation in face of network partition through use of optimistic replicated storage.

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- Demonstrate technology for detecting the presence of malicious intruders through statistical profiling and behavioral models of benign and malicious users.
- Develop microsystems design. ($2.6M)

(U) FY 1998 Program:

- High Confidence Networking. ($9.0M)
  - Release reference implementation of secure Border Gateway Protocol routing protocol.
  - Release library of application embeddable network security services.
  - Demonstrate secure signaling and call set-up for Asynchronous Transfer Mode networks.
- High-Confidence Computing. ($12.9M)
  - Commercial certified B3 workstation featuring trusted computing base available.
  - Prototype Common Object Request and Broker (CORBA)-compliant Domain and Type Enforcement for secure location interoperability.
  - Trusted, high assurance operating system kernel extensions.
  - Demonstrate integrated security support in prototype extensible operating system.
- Assurance and Integration. ($8.4M)
  - Complete design tools for inferring system-level properties in composed systems.
  - Complete tools for secure refinement of secure software architectures.
- Survivability for Large Scale Systems. ($15.5M)
  - Demonstrate a primitive survivable "immune system" for responding to attacks and intrusions.
  - Demonstrate resource allocation mechanisms for adaptive system of systems.

(U) FY 1999 Program:

- High Confidence Networking. ($12.0M)
  - Demonstrate suite of secure reliable distributed applications over mobile and wireless networks.
- High-Confidence Computing. ($12.1M)
  - Demonstrate techniques for general pairwise tradeoffs among fault-tolerance, real-time operations and security.
- Assurance and Integration. ($7.0M)
  - Characterize a set of security and fault-tolerance techniques by strength and cost, for plug-and-play wrappers.
  - Demonstrate integration of security composition techniques into software engineering tools.

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- Survivability for Large Scale Systems. ($15.0M)
  - Demonstrate Adaptive Architecture for Survivable System of Systems.
  - Develop techniques for diagnosing multi-agent multi-staged attack.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	35.0	38.1	45.5	44.0
Appropriated	27.8	34.7	N/A	N/A
Current Budget	26.1	34.7	45.8	46.1

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects program repricing and transfer of SBIR funds to program element 0605502E.
FY 1998-99 Increases reflect program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Biological Warfare Defense PE 0602383E, R-1 #14

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Biological Warfare Defense Program BW-01	0*	0*	61,600	61,800	50,500	44,000	45,648	40,000	Continuing	Continuing

* The program has received approval as a stand alone effort in the FY 1997 DoD Authorization Act and leverages activities previously funded in PE 0602712E, Project MPT-01 in FY 1996 and PEs 0601384BP, 0602384BP, and 0603384BP in FY 1997.

(U) **Mission Description:** This program element funds projects supporting revolutionary new approaches to biological warfare (BW) defense. Today, there is a tremendous mismatch between the magnitude of the biological warfare threat and the Department's ability to adequately respond. The widespread availability of bacterial, viral, and toxin stocks; minimal developmental cost and scientific expertise required; and abundance of weaponization potential comprise a sinister threat. The single largest concern, however, is from the exploitation of modern genetic engineering by adversaries to synthesize "super pathogens." Recent dramatic developments in biotechnology, which this program will leverage, promise to eliminate this mismatch.

(U) Efforts to counter the BW threat include developing barriers to block entry of pathogens into the human body, pathogen countermeasures to stop pathogen virulence and to modulate host immune response, medical diagnostics for the most virulent pathogens and their molecular mechanisms, biological and chemically-specific detectors, and informatics tools. Program development strategies will include collaborations with the pharmaceutical, biotechnology, government, and academic centers of excellence.

(U) Pathogen countermeasures to be developed include: (1) multi-agent therapeutics against known, specific agents and (2) therapeutics against virulence pathways shared by broad classes of pathogens. Specific approaches include modified red blood cells to sequester and destroy pathogens, modified stem cells to detect pathogens and produce appropriate therapeutics within the body, identification of virulence mechanisms shared by pathogens, development of therapeutics targeting these mechanisms, and efficacy testing in cell cultures and animals.

(U) The ability to detect biological warfare agents on the battlefield in real time with no false alarms is a crucial requirement. To address this requirement, the program will create more efficient and effective miniature sampling devices that concentrate contaminated air and enhance the ability to capture biological warfare agents. Second, the program will develop a new range of antibodies or design small molecules to bind specific agents (to replace the lower affinity antibodies currently used). In order to detect that the binding of an agent has occurred, the event must be "magnified." Traditionally this is done by tagging the antibody molecule with a fluorescent probe.

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This program will replace the noise-plagued fluorescent tags with Up-Converting Phosphors and magnetic beads with the sensitivity to detect a single binding event, minimizing the size of the sample required, saving time, and decreasing the number of false positive alarms. Finally, the use of fluids as a requirement for biological agent detection will be eliminated and replaced by a miniaturized (shoe box size) time-of-flight mass spectrometer.

(U) Mission effectiveness requires rapid, correct medical responses to biological weapon threats or attacks. A portion of this project will provide comprehensive protocols to protect or treat combatants by using current and emerging biological countermeasures. It will provide accelerated situational awareness for biological warfare events by detecting exposure to agents through an analysis of casualty electronic theater medical records and will locate and determine the most effective logistical support for providing appropriate treatment and pathogen-specific resources required to mitigate effects of the attack.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program: N/A

(U) FY 1998 Program:

- Pathogen Countermeasures. ($43.1M)
  - Optimize the detection of specific pathogens by stem cells (in cell culture).
  - Determine the impact of modified red blood cells on vascular and immune systems.
  - Define animal models in which to test the efficacy of modified red blood cells to defend against pathogens.
  - Develop enzymes or other active molecules which can be attached to the surface of red blood cells to detect and destroy pathogens.
  - Establish a portfolio of strategies to:
    * inhibit the expression of disease-causing (virulence) factors by pathogens.
    * disrupt the disease-causing (virulence) communications between pathogens.
    * modulate the body's response to the presence of a pathogen.
    * assess feasibility of novel polymeric materials to protect against pathogen exposure.
  - Assess the feasibility of an array based instrument (or other novel technologies) for multi-agent pathogen diagnosis in medical samples.

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- Sensors. ($10.0M)
  - Develop hierarchical database of mass signatures for use in detecting selected bacteria with a mass spectrometer.
  - Investigate methods for determining biological warfare agent bacterial and viral viability (agent live or dead).
  - Design a gridded array detector for use with Up-Converting Phosphors.
  - Demonstrate the feasibility of using giant magnetoresistance for the detection of magnetic bead-tagged pathogens.
  - Fabricate and test a wick device, an integral sample pump, and a reagent reservoir system suitable for use in a handheld Up-Converting Phosphor detector.
  - Continue development of a portfolio of air sampling devices for airborne biological materials.
- Informatics. ($8.5M)
  - Demonstrate a biological warfare Anchor Desk that provides agent-specific biological warfare (BW) situational awareness, decision and execution support with linkages to the Logistics Anchor Desk (LAD) for BW-specific logistical information.
  - Develop agent-specific "software antibodies" for detection, protection, and treatment directives to medical personnel for BW threats that will decrease response time.
  - Develop quantitative measures of operational assessment using Medical Readiness Indicators (metrics based indicators of individual and unit level readiness) and realistic BW training algorithms to improve BW medical responses.

(U) <u>FY 1999 Program</u>:

- Pathogen Countermeasures. ($46.3M)
  - Develop a modified stem cell which can both detect and produce a prophylactic/therapeutic response to a pathogen (in cell culture).
  - Define animal models in which to test the efficacy of modified stem cells to prevent disease.
  - Determine in-vitro toxicity of modified stem cell-produced therapeutics.
  - Demonstrate in laboratory animals the efficacy of modified red blood cells to eliminate pathogens from the blood for the purpose of potential defense against biological warfare agents.
  - Determine pathogen detection and elimination efficacy for modified red blood cells with enzymes or other active molecules attached to their surfaces.
  - Demonstrate selected strategies (in cell culture) to:
    * inhibit the expression of disease-causing (virulence) factors by pathogens.
    * disrupt the disease-causing (virulence) communications between pathogens.

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* modulate the body's response to the presence of a pathogen.
- Develop polymeric materials for pathogen protection.
- Develop an array based instrument to identify specific pathogens in medical samples.

• Sensors. ($9.5M)
- Determine chemotaxonomic biomarkers for selected viral substances for detection in the mass spectrometer.
- Develop techniques for DNA sequencing of bacterial spores and viruses with a mass spectrometer.
- Demonstrate replacement of a surface-bound antibody with a "designer" small molecule for high affinity pathogen capture.
- Perfect the Up-Converting Phosphor detection system so that a single gene can be detected without amplification in mixtures of unknown genes.
- Modify the prototype of a portable biodetection system following Dugway Proving Ground test results.

• Informatics. ($6.0M)
- Complete development, perform additional field tests, and transition software antibodies, biological warfare (BW) knowledge base, BW Medical Readiness Indicators, and maintenance tools to the Services.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0	0
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0	0	61.6	61.8

(U) **Change Summary Explanation**:

FY 1998-99 Increase is attributable to establishment of a new program for Biological Warfare Defense.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Tactical Technology
PE 0602702E, R-1 #16

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tactical Technology	**120,440**	**121,520**	**155,329**	**177,995**	**174,119**	**223,597**	**253,586**	**278,434**	**Continuing**	**Continuing**
Naval Warfare Technology TT-03	38,464	31,714	10,222	28,296	49,553	59,172	59,172	60,172	Continuing	Continuing
Advanced Land Systems Technology TT-04	31,708	21,247	26,000	30,000	33,909	51,686	61,686	69,886	Continuing	Continuing
Advanced Targeting Technology TT-05	6,857	0	0	0	0	0	0	0	0	N/A
Advanced Tactical Technology TT-06	36,983	35,346	64,069	62,534	62,024	62,728	72,728	82,728	Continuing	Continuing
Aeronautics Technology TT-07	2,100	14,880	18,000	19,500	8,000	30,011	30,000	35,648	Continuing	Continuing
Advanced Logistics Technology TT-10	4,328	18,333	25,738	27,665	10,633	10,000	20,000	20,000	Continuing	Continuing
Joint Logistics ACTD TT-11	0	0	11,300	10,000	10,000	10,000	10,000	10,000	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because it supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The Tactical Technology program element funds a number of projects in the areas of Naval Warfare, Advanced Land Systems, Advanced Tactical, Aeronautics, and Advanced Logistics technologies.

(U) The Naval Warfare Technology project is focusing on: Simulation Based Design (SBD) and Command, Control, Communications and Intelligence/Synthetic Environments (C3I/SE). The Simulation Based Design program will provide the tools required to integrate cost, performance and manufacturing considerations throughout the design process. The SBD program is developing and demonstrating a prototype infrastructure that will enable a significant positive change in the acquisition process for large, complex warfighting systems utilizing virtual prototypes in synthetic environments. In the C3I/SE program, advanced information technologies are being integrated into advanced prototype

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systems to provide improved battlefield awareness and dominance to mobile command centers in the field. In FY 1997, the effort was expanded to include the Collaborative Crisis Understanding program. Also funded in this project is the 3-D high-resolution Digital Terrain Mapping effort.

(U) The Advanced Land Systems Technology project is developing technologies for contingency missions and military Operations-Other-Than-War (OOTW) to make U.S. combat forces more deployable, effective, survivable, and affordable. The SLID program will develop and test a system for providing protection against missiles and projectiles with explosive warheads. The Foreign Cooperative Demonstration program will concentrate on enhancing the survivability of armored vehicles. The Magic Vision program will generate obscurant smoke to deny adversary forces the ability to see on the battlefield while providing our forces with image sensors to see through smoke. The Advanced Fire Support Systems program will provide rapid response and lethality associated with gun and missile artillery, thereby increasing survivability, yet it will require less personnel and logistical support. The Unexploded Ordnance Detection program will develop sensors for the chemically specific detection of explosives or other chemicals, comparable to the effectiveness of canine olfaction detection.

(U) The Advanced Tactical Technology project is exploring the application of compact lasers; compact high-density holographic data storage and high performance computational algorithms to enhance performance of radars, sensors, communications, and electronic warfare and target recognition and tracking systems. The technologies under development will improve passive infrared signature suppression, tactical landing systems, miniature air-launched decoy systems, and affordable rapid response missile demonstration.

(U) The Aeronautics Technology project will develop and demonstrate a new family of Micro-Aerial Vehicles (MAVs). The MAVs will be an order of magnitude smaller than any operational UAV and will be useful in a wide variety of military missions from covert imaging and chemical/biological agent detection to communication enhancement. The feasibility of developing a family of Unmanned Tactical Aircraft (UTAs) will be investigated and demonstration of a Urban Combat Vehicle (UCV) will be demonstrated. This UCV, a small, inexpensive aircraft, will be able to proceed to the target area, identify a potential target and release a loitering weapon or weapons with the assistance of a ground-based controller.

(U) The Advanced Logistics project is investigating and demonstrating technologies that will make a fundamental difference in transportation and logistics. The program will define, develop, and demonstrate fundamental enabling technologies that will permit forces and sustainment materiel to be deployed, tracked, refurbished, sustained, and redeployed more effectively and efficiently than before.

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(U) The Joint Logistics Advanced Concepts Technology Demonstration (ACTD) is a program that will provide hands-on demonstrations of existing and evolving logistics tools to facilitate their introduction into the service logistics community. Initial demonstrations will focus on near-term capabilities that can operate within the Global Combat Support System. Follow-on demonstrations will integrate enhanced asset tracking and transportation models with advanced Command and Control systems under development (i.e. the Battlefield Awareness and Data Dissemination ACTD).

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Tactical Technology, PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Naval Warfare Technology TT-03	38,464	31,714	10,222	28,296	49,553	59,172	59,172	60,172	Continuing	Continuing

(U) **Mission Description:** The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. The enabling technologies include: Virtual prototyping and advanced modeling to radically change the DoD acquisition process through integrated product and process design; integrated ship sensor, weapons and platform technologies to demonstrate the feasibility of reduced ship manning; techniques that will reduce acquisition costs through greater reliance on commercially available components for quiet electric ship propulsion, and corrosion-resistant composite materials and coatings; all weather interferometric sensors for precision 3-D characterization and surveillance of littoral environment for smart Naval Fire Support (NFS) weapons; and Command, Control, Communications, and Intelligence/Synthetic Environments (C3I/SE) for littoral warfare.

(U) The Simulation-Based Design (SBD) Program is developing, testing, and transitioning to the military services, a prototype digital knowledge environment for representing physical, mechanical, and operational characteristics of a complex system. Such an environment will enable a significant positive change in the acquisition process for large, complex warfighting systems. SBD will utilize virtual prototypes in synthetic environments to enable effective, integrated product and process development. The program will integrate the technologies of distributed interactive simulation, physics-based modeling, and virtual environments and apply them to the design, acquisition, and life cycle support processes of systems. Complete simulation, from the concept formulation stage through verification of requirements, to design, manufacture, operation, training, and logistics, will be available prior to initiation of construction. Successful development and deployment of SBD will reduce the cost and acquisition time for DoD systems. SBD will be applicable to all subsystems, from mechanical to large scale electronic, within an overall system and it will enable cost savings by reducing the need for expensive physical mockups and by eliminating many of the manufacturing inefficiencies caused by inadequate design. Overall product quality and capabilities will be enhanced by the timely insertion of the latest technological advances into designs as they progress through the shortened acquisition cycle. SBD will be applicable to a broad range of system domains including land vehicles, aircraft, satellites and marine vehicles.

(U) In the Ship Systems Automation (SSA) area, advanced, highly automated sensor, weapons control, and platform systems (including casualty control) are being developed and demonstrated for submarine and surface ship applications. Through evolving sequential technology demonstrations, efforts in this area will show how an integrated collection of automated systems could achieve an order of magnitude reduction in crew size. Because

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personnel account for a significant portion of current ships' life cycle costs, such a reduction would lead to immediate and long term cost savings for ship acquisition programs. SSA technology developments include intelligent command-level advanced reasoning components, scalable sensor integration work stations to fuse multi-source data and intelligently display the tactical scene on a situation assessment system, cooperating expert agents conducting mission-context/sensor employment planning, and integrated internal condition sensor and control systems to intelligently display and control ship physical conditions on a ship's internal assessment system.

(U) The Advanced Electric Ship program, planned for FY 1999, will develop and demonstrate critical technologies that are focused toward the affordability of future ships. Candidates to be considered include extensive use of advanced electrical machinery and control systems to take advantage of Commercial-Off-the-Shelf (COTS) equipment, and electric drive for ship's propulsion. Other areas for consideration will include widespread use of composites and development of advanced coating systems for reduced maintenance.

(U) 3-D High-Resolution Digital Terrain Mapping will support the Naval Fire Support (NFS) missions in the littoral environment by development of advanced 3-D radar technologies which will enable the Commander Joint Task Force (CJTF) to obtain precise realtime 3-D maps of littoral environments. These precision 3-D maps provide accurate position information of all objects in the littoral theater and will be required for next generation smart munitions and surveillance systems. All weather interferometric sensors for precision 3-D characterization and surveillance of littoral environment will require the development of broadband planar antenna active arrays, precision attitude measurement systems using inertial navigation systems tightly coupled with space based precision frequency and time sources. This effort will also develop and demonstrate advance radar waveforms and processing algorithms required for precision geolocation by standoff sensors.

(U) In the Command, Control, Communication, and Intelligence/Synthetic Environment (C3I/SE) area, advanced information technologies are being integrated and applied to provide improved battlefield awareness and battlefield dominance to mobile command centers in the field (e.g., Force Commanders, Commander Joint Task Force (CJTF), and deployed Joint Special Operations Task Force (JSOTF) Commanders). The advanced prototype systems developed under this program integrate the latest technologies in high-bandwidth communications, object oriented information system, collaborative planning, intelligent database access, image processing, data exploitation, and high performance computing to address the unique (quick reaction and real-time execution) requirements of forward deployed, mobile commanders. It also develops the Synthetic Test Range (STR), which in conjunction with the Simulation Based Design

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(SBD) development, is aimed at improving the acquisition process. The STR concluded in FY 1996 and transitioned to Naval Sea Systems Command. In FY 1996, the program began emphasizing collaborative crisis understanding and mitigation, developing tools and systems necessary to recognize, understand, forecast, and defuse potential crisis situations. Collaborative Crisis Understanding will substantially reduce the time necessary to form teams, analyze crisis data, and develop and brief response options. This effort is focused on the National Command Authority, National Security Council, and the National Military Command Center.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Conducted Simulation-Based Design (SBD) prototype demonstrations on a complex ship application at distributed design and visualization centers linked via nationwide networks; the first, a joint demonstration in support of the Defense Modeling and Simulation Office High Level Architecture; the second, a virtual prototype of a ship combat system using an electronic smart product model to demonstrate functional requirements. ($9.5M)
- Initiated expansion of Simulation-Based Design (SBD) through application to development programs for small rapid satellite manufacturing, selected aircraft sub-system manufacturing, land vehicle power train design, and ship manufacturing enterprise. ($4.9M)
- Conducted high fidelity radar simulation with an operational radar system, transitioned to Navy users. ($1.8M)
- Initiated collaborative crisis understanding and mitigation effort, developed concept of operations and visualization demonstration emphasizing data mining, modeling and collaboration in response to pre-crisis indicators. ($1.7M)
- Conducted demonstration and testing of campaign operations planning system applied to joint forces command and control in a deployable package. ($3.9M)
- Demonstrated advanced Ship Systems Automation (SSA) technologies that enable a few operators to collaborate with advanced-reasoning systems to manage the construction of a complex multi-warfare, multi-sensor fusion tactical scene and the effective operation of a combatant ship in that scene. Intelligent System Interface and advanced sensors technologies will continue to be developed and demonstrated. ($9.8M)
- Continued the most promising ocean sciences efforts at the Center of Excellence for Research in Ocean Sciences (CEROS). Issued a Broad Agency Announcement and selected eleven innovative marine technology projects for initiation. ($6.9M)

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(U) FY 1997 Program:

- Conduct interim Simulation-Based Design (SBD) prototype engineering demonstration tests, in conjunction with ongoing acquisition programs of the multi-disciplinary engineering analysis capability supported by the advanced computational core architecture. ($8.4M)
- Initiate SBD prototype engineering tests of the smart product model in support of integrated life cycle requirements and analyses of an evolving maritime application. ($2.2M)
- Demonstrate automated situation assessment and fusion of a complete multi-warfare tactical scene (air, surface, subsurface), tactical planning, and self-defense capabilities for ship and associated command platforms. Also demonstrate advanced reasoning systems for platform monitoring and control, intelligent construction and presentation of platform status and planning, and automated damage control/recovery reasoning. ($6.6M)
- Initiate the development of a software system for collaboratively constructing quantifiable crisis and an "intelligent agent" which can browse across dissimilar, existing databases. ($2.0M)
- The following activities were funded by Congressional additions to the FY 1997 President's Budget:
  - Ship Systems Automation (SSA) - Install, test, and deploy on a Navy submarine the SSA Tactical Scene Operator/Associate (TSO/S), a multi-hypothesis data fusion system which analyzes sensor data and intelligence reports and displays the surface/subsurface tactical scene. ($2.5M)
  - Simulation-Based Design (SBD) - Make available SBD prototype software to DoD Service's beta sites and acquisition programs for use, evaluation, and feedback. ($3.0M)
  - Center of Excellence for Research in Ocean Sciences (CEROS) - Continue most promising ocean sciences efforts at the CEROS. ($7.0M)

(U) FY 1998 Program:

- Continue systems development and initiate development of a tool for rapid, collaborative plan development, evaluation, and briefing; demonstrate and evaluate retrieval agents; demonstrate use of access templates and profiles; evaluate filters. Demonstrate the ability to navigate several of the most important, crisis-related databases for acquiring information on a simulated crisis. ($3.6M)
- Evaluate ability to quantify centers-of-gravity and pressure points for plan development, and demonstrate modeling capabilities at Joint Task Force ATD/Global Command and Control System Insertions. Demonstrate crisis briefing capability for prioritizing policy and plans at National Security Council/National Military Command Center and supporting intelligence agencies. ($5.1M)
- Design a system-level brassboard demonstration of a lightweight, very broadband, phased-array-antenna and attitude-measurement system capable of 3-D, high-resolution Digital Terrain Mapping. ($1.5M)

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(U) FY 1999 Program:

- Demonstrate initial operational capability of the data retrieval and visualization capability, initial operational capability of the crisis modeling capability, and begin installation of modeling capability and integration with data retrieval capability at CIA/NMJIC. Begin installation and integration of advanced briefing capability. ($6.6M)
- Conduct shore based demonstration for a Direct Current (DC) bus controlling a broad array of variable electric loads using Commercial-Off-the-Shelf (COTS) components. The demonstration will be focused toward an all-electric ship. ($9.9M)
- Design and construct a 3-D, high-resolution Digital Terrain Mapping system employing planar array covering 8 to 18 GHz in a low-cost lightweight conformal structure, attitude-measurement system, and reconstruction algorithms. ($11.8M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	39.5	32.6	24.8	33.0
Appropriated	39.2	39.6	N/A	N/A
Current Budget	38.5	31.7	12.2	28.3

(U) **Change Summary Explanation**:

FY 1996 Reflects program repricing and reprogramming of SBIR funds to a separate PE.

FY 1997-98 Decrease reflects phase down of the Simulation Based Design (SBD) and Ship Systems Automation (SSA) Programs that are scheduled to be completed at the end of FY 1997.

FY 1999 Decrease reflects completion of SBD and SSA, offset by initiation (FY 1998) and expansion (FY 1999) of 3D mapping radar efforts and affordable ship initiatives.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Land Systems Technology TT-04	31,708	21,247	26,000	30,000	33,909	51,686	61,686	69,886	Continuing	Continuing

(U) **Mission Description:** This project is intended to develop technologies for contingency missions and military Operations-Other-Than-War (OOTW) to make U.S. combat forces more deployable, effective, survivable, and affordable. This project supports seven main efforts: Small Low-Cost Interceptor Device (SLID) and SLID Testing; a Foreign Cooperative Demonstration; Day Sight; Advanced Fire Support Systems; Unexploded Ordinance Detection; OOTW; and Small Unit Operations (SUO).

(U) The SLID program is developing and testing a system for providing protection against missiles and projectiles with explosive warheads. This system will detect, track and intercept these threats at a standoff distance sufficient to render them ineffective. Applications for the SLID system include: self-defense of vehicles; high value fixed sites such as command centers, parked aircraft and radars; and may be extended to naval platforms and low-speed aircraft.

(U) The Foreign Cooperative Demonstration program is fabricating and demonstrating a new system for enhancing the survivability of armored vehicles based on technology developed by a foreign source.

(U) The Magic Vision Program will develop and demonstrate an integrated system that will generate obscurant smoke to deny adversary forces the ability to see on the tactical battlefield, while providing our forces with thermal imaging sensors to see through the smoke. The proliferation of short wavelength infrared (SWIR) (less than 1 mm) image intensifier night vision goggles is diminishing US forces' advantage in nighttime tactical operations. Magic Vision will demonstrate the potential to regain this advantage. The program will investigate the integration of man-portable, non-toxic, environmentally friendly smoke generation with head-mounted, uncooled long wavelength infrared (LWIR) (8 - 12 mm) sensors. The smoke to be used will obscure visibility through SWIR in all operations (day/night, tactical, small unit operations, etc.), but will transmit the LWIR. Based on over two decades of DARPA-pioneered research in uncooled LWIR focal plane arrays, the US has a significant technical advantage in this technology. The concept can be exploited further with Combat ID systems which operate in the LWIR. The sensor technical challenges include sufficiently low weight, power, bulk, and cost for realistic man portable applications. The smoke challenges will include man-portability (3 - 5 gallons), rapid dispensing (45 seconds), cloud area (400 square meters), and cloud persistence (20 minutes in absence of wind).

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(U) The Advanced Fire Support Systems program will develop and test systems to provide the rapid response and lethality associated with gun and missile artillery in packages which require significantly fewer personnel, require decreased logistical support, and have increased survivability compared to current systems. The program will develop and demonstrate a highly flexible system including a guided projectile/munition, a remotely commanded self positioning launcher, and a command and control system compatible with military doctrine.

(U) The Unexploded Ordnance (UXO) Detection program will develop sensors for the chemically specific detection of explosives or other chemicals characteristic of land mines and/or shallowly buried UXOs. The sensors developed under this program will provide soldiers with the effectiveness of canine olfaction detection without the logistics and other constraints imposed by the use of live animals. These chemically specific sensors will work either singly or in conjunction with other technologies (such as the hyperspectral mine detector, developed under the Small Unit Operations (SUO) program) that exploit different physical features.

(U) OOTW encompassed a wide range of activities where military power is used for purposes other than large scale combat. The purpose of the DARPA OOTW research and development program was to develop and demonstrate technologies that increase operational effectiveness in the multi-national, multi-lingual OOTW environment. Funding for this program was completed in FY 1996.

(U) The SUO program is developing the key technologies to enable more capable, dispersed military units to effectively perform warfighting operations traditionally accomplished with massed forces. The SUO program focuses on enabling comprehensive awareness at the tactical level in restrictive environments. Sniper/mortar detection and hyperspectral infrared mine detection work initiated under the OOTW program will be continued with an emphasis on small unit operations. In FY 1997, these SUO efforts were realigned into Project LNW-02.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Operations-Other-Than-War (OOTW) and Unexploded Ordnance (UXO). ($7.7M)
  - Completed the Soldier 911 demonstrations in Korea and Macedonia, and the Korean/English text translator.
  - Completed modular tag concept definition phase.
  - Continued mine/unexploded ordnance detection technology development, including chemically-specific detection techniques such as nuclear quadruple resonance.

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- Completed background/clutter data collection at four sites using traditional sensors as well as preliminary tests to determine the chemical signature in and around buried mines.
- Demonstrated the Korean/English speech translator, the concealed weapons system, extremity armor, and limited effects technology.
- Demonstrated a vehicular mounted surveillance and dazzler system, improved (less lethal) pyrotechnic devices, and a wireless stun projectile.

• Continued development of sniper, mortar, hyperspectral infrared mine, and thru-wall detection technologies with emphasis on small unit operations. ($10.8M)
• Initiated Small Low-Cost Interceptor Device (SLID) phase II fabrication and testing effort with remaining contractors. Performed sub-system tests leading to static system tests. ($11.2M)
• Initiated development of the system for the Foreign Cooperative Demonstration. ($2.0M)

(U) FY 1997 Program:
• Continue SLID phase II effort. Conduct full system static tests and tests against slowly moving targets. Prepare for live-on-live tests. ($12.5M)
• Complete the Foreign Cooperative Demonstration testing and transition program to the Army. ($1.9M)
• Continue chemically-specific unexploded ordnance/mine detection technology development. Characterize explosive and other related chemical contamination at minefield. Evaluate advanced algorithms and sensor fusion capabilities for multiple-sensor detection. ($6.8M)

(U) FY 1998 Program:
• Complete live-on-live Small Low-Cost Interceptor Device (SLID) testing. ($7.0M)
• Field demonstration of laboratory scale system for chemically specific detection of land mines. ($12.0M)
• Initiate the Advanced Fire Support System development including concept and requirements analysis of loitering platforms and unmanned missile artillery packages, Phase I system designs, and hardware risk mitigation experiments. ($4.0M)
• Assess current state of relevant smoke and LWIR sensor technologies; determine needed modifications or improvements; select a single application (such as Small Unit Operations or Military Operations in Urban Terrain) for demonstration; and design and execute demonstration. ($3.0M)

(U) FY 1999 Program:
• Extend SLID protection range, demonstrate application to high value fixed sites, and transition to the U.S. Army. ($7.0M)

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- Develop Phase II Advanced Fire Support System and participate in limited objective experiments and service warfighter exercises. ($13.0M)
- Field demonstration of prototype chemically specific land mine detector paired with other sensors as appropriate. ($10.0M)

(U) **Program Change Summary**: *In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	35.7	22.1	19.0	30.0
Appropriated	33.2	23.2	N/A	N/A
Current Budget	31.7	21.2	26.0	30.0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects minor program repricing.
FY 1997 Reflects minor rephasing of the Unexploded Ordinance/Mine Detection program and minor repricing of SLID testing.
FY 1998 Increase reflects addition of Day Sight and Advanced Fire Support Systems program.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Tactical Technology TT-06	36,983	35,346	64,069	62,534	62,024	62,728	72,728	82,728	Continuing	Continuing

(U) **Mission Description:** This project focuses on eight broad technology areas: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasures, laser radar and sensors; (b) compact high density holographic data storage for high bandwidth image processing and access to large data bases; (c) high performance computational algorithms for signal processing, target recognition and tracking, electromagnetic propagation, and processing of advanced materials and microelectronics; (d) precision optics components for critical DoD applications; (e) passive infrared signature suppression to counter air-to-air missile threats; (f) tactical landing systems;(g) miniature air-launched decoy systems; and (h) an affordable rapid response missile demonstration.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Compact Lasers. ($7.3M)
  - Demonstrated compact lasers at mid-infrared wavelengths for infrared (IR) countermeasures.
  - Demonstrated mid-infrared lasers with 2 watts output power and a modulated pulse repetition frequency of 10 kilohertz, packaged in a compact configuration for field testing.
  - Demonstrated pulsed operation of quantum cascade diode lasers operating at mid-infrared wavelengths.
  - Demonstrated frequency conversion into mid-infrared wavelengths using periodically poled lithium niobate crystals.
- Holographic Data Storage. ($5.9M)
  - Performed technology demonstration to establish system trade-offs of various candidate materials for holographic data storage.
  - Demonstrated proof-of-principle digital holographic data storage devices to establish the capability of various multiplexing methods and error detection and correction schemes.
- Fast Computational Algorithms. ($13.2M)
  - Demonstrated wavelet-based methods for automatic target detection and recognition.
  - Demonstrated multiresolution methods and adaptive waveforms for image formation and processing.
  - Developed hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of both wavelets and nonlinear partial differential equation-based methods.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-06

- Developed 3D implementation of fast multipole method for radar cross section calculations.
- Identified approaches to reducing high-order nonlinear descriptions of thin film processes to real-time sensing and control models.

• Precision Optics Technology. ($2.7M)
- Developed requirements and performed initial calculations for conformal and off-axis optical components for next generation tactical systems.

• Advanced Infrared Signature Suppression. ($.9M)
- Integrated and demonstrated (flight test) a long-wave infrared (LWIR) suppression system.

• Tactical Landing System (TLS). ($6.3M)
- Fabricated and demonstrated a transportable TLS designed for minimal installation/calibration times; accuracy improved through the addition of phase measurement capability; integrity monitoring feature added to permit autonomous operation.

• Miniature Air-Launched Decoy. ($.7M)
- Conducted engine independent validation and established system design.

(U) <u>FY 1997 Program</u>:

• Compact Lasers. ($5.9M)
- Demonstrate breadboard systems of compact high power tunable mid-infrared lasers, and laser diodes operating at mid-infrared wavelengths.
- Demonstrate breadboard tunable mid-infrared lasers with 20 watt output power at 20 kilohertz (kHz) pulse repetition rate for ship defense.
- Demonstrate room temperature operation of continuous wave mid-infrared laser diodes.
- Demonstrate active tracking system at mid-infrared wavelengths.

• Holographic Data Storage. ($5.1M)
- Technology demonstration to establish functional limits of holographic data storage.
- Demonstrate 1 terabit storage capacity for functional evaluation of write once and read many type storage systems.

• High Performance Algorithm Development. ($10.6M)
- Demonstrate classification performance improvement for Longbow fire control radar achieved using a wavelet classifier.
- Apply adaptive waveform designs to radar and communication.
- Apply multiresolution methods to image processing and formation.
- Select applications for development of wavelet-based detection, discrimination, and classification strategies.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-06

- Develop new strategies for data, sensor, and algorithm fusion for signal and image processing applications that exploit the feature extraction capability of wavelets.
- Demonstrate orders-of-magnitude processing reductions provided by parallel implementation of fast multipole techniques to radar cross section calculations.
- Develop methods for calculating electromagnetic scattering from objects in ground clutter.

• Advanced Mathematics for Microstructural Process Control. ($4.4M)
- Enhancement of strategies for physicochemical modeling of thin film vapor deposition processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
- Develop fast algorithms for modeling and design of large-scale, high-performance circuits.

• Precision Optics Technology. ($6.3M)
- Continue development of conformal and off-axis optical components for tactical systems.
- Develop magneto-rheological finishing for aspheres, toroids and cylinders.
- Demonstrate design tools for conformal and off-axis optical systems.

• Miniature Air-Launched Decoy (MALD). ($3.0M)
- Establish MALD critical design and final design specifications. Conduct flight testing with proof-of-concept vehicle and risk reduction testing on engine. Begin flight system fabrication, integration, assembly and qualification testing of subsystems. Initiate Seek Eagle Process. Begin refinement of operational concept for MALD.

(U) <u>FY 1998 Program</u>:

• Compact Lasers. ($5.5M)
- Demonstrate compact high power tunable lasers and laser diodes at mid-infrared wavelengths.
- Develop breadboard tunable mid-infrared lasers for airborne infrared countermeasures.
- Demonstrate room temperature long wavelength laser diodes in the 7-to-9 micrometer wavelength range.

• Holographic Data Storage. ($4.1M)
- Demonstrate 1 terabit storage capacity for functional evaluation of read/erase type storage systems.

• High Performance Algorithm Development. ($13.9M)
- Implement a hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of wavelets and nonlinear partial differential equation-based methods.
- Develop application-specific wavelet-based automatic target recognition algorithms.
- Continue development of most promising strategies for data, sensor, and algorithm fusion that exploit the feature extraction capability of wavelets and apply to signal and image processing.
- Develop prototype electromagnetic scattering models for objects in ground clutter.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-06

- Demonstrate toolboxes for generating optimal portable Fast Fourier Transforms and wavelet algorithms and apply to high dimensional synthetic aperture radar.
- Develop mathematical approaches to developing optimal portable applications libraries for selected computational kernels required in thin film process simulations.
- Determination of most promising data exploitation approaches for biochemical structure information.

• Advanced Mathematics for Microstructural Process Control. ($7.9M)
- Develop physicochemical models for thin film vapor deposition processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
- Implement fast algorithms for modeling and design of large-scale, high-performance circuits.
- Develop reduced order physiochemical models and algorithms for real-time sensing and control of thin film vapor deposition processes.

• Precision Optics Technology. ($6.8M)
- Continue development of conformal optical system components for tactical systems.
- Complete designs of conformal optics sensor systems and down select demonstration candidate from airborne platforms or missiles.
- Fabricate aspheric optical components and diffractive optical elements on curved substrates.
- Demonstrate metrology tools.

• Miniature Air-Launched Decoy (MALD). ($19.2M)
- Fabricate and deliver flight test vehicles.
- Conduct flight readiness review.
- Continue ground testing and initiate flight testing for flight certification.
- Continue ground and flight maintenance training and begin operational training.
- Complete Seek Eagle process.

• Affordable Rapid Response Missile Demonstration (ARRMD). ($6.7M)
- Begin missile concept development, including manufacturing process definition, propulsion integrated flowpath demonstration and manufacturability demonstration.
- Define flight test plan.
- Begin affordability assessment.
- Conduct mission assessment.

(U) <u>FY 1999 Program</u>:

• Compact Lasers. ($5.3M)
- Complete demonstration of compact high power tunable lasers and laser diodes at mid-infrared wavelengths.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-06

- Develop packaged tunable mid-infrared lasers for airborne infrared countermeasures.
- Complete demonstration of laser diode arrays operating at mid-infrared wavelengths.

• High Performance Algorithm Development. ($17.4M)
- Demonstrate hybrid automatic target recognition strategy for synthetic aperture radar exploiting most advantageous features of wavelets and nonlinear partial differential equation-based methods.
- Demonstrate application-specific wavelet-based automatic target recognition algorithms.
- Validate prototype electromagnetic scattering models for objects in ground clutter.
- Develop data, sensor, and algorithm fusion algorithms for signal and image processing applications that exploit the feature extraction capability of wavelets.
- Demonstrate fast algorithms for modeling and design of large-scale, high-performance circuits.
- Develop prototype toolboxes for generating optimal portable applications libraries for selected computational kernels required in thin film process simulations.
- Develop data exploitation approaches for biochemical structure information.
- Develop efficient algorithms for predicting tertiary structure of biomolecules.

• Advanced Mathematics for Microstructural Process Control. ($10.8M)
- Validate physicochemical models for thin film processes that integrate process, sensing, and control considerations and provide understanding of critical microstructure issues needed to design high-quality and high yield manufacturing processes.
- Validate reduced order models and algorithms for sensing and control of thin film vapor deposition processes.

• Precision Optics Technology. ($6.5M)
- Continue development of conformal optical system components.
- Demonstrate near net-shape growth of conformal windows.
- Laboratory assembly, demonstration and test of conformal sensor systems.

• Miniature Air-Launched Decoy (MALD). ($14.0M)
- Continue operational demonstrations, acquire flight certification and transition to Services.

• Affordable Rapid Response Missile Demonstration (ARRMD). ($8.5M)
- Complete propulsion integrated flowpath demonstration and manufacturability demonstration.
- Perform unit cost analysis.
- Conduct Warfighting Analysis Lab exercises.

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DATE February 1997

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Tactical Technology,
PE 0602702E, Project TT-06

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	39.4	46.0	50.6	56.4
Appropriated	39.5	41.2	N/A	N/A
Current Budget	37.0	35.3	64.1	62.5

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects minor program repricing ($+1.1 million); offset by Bosnia reprogramming action ($-2.4 million) and reprogramming of Small Business Innovative Research (SBIR) funds to PE 0605502E ($-1.2 million).

FY 1997 Decrease due to rephasing of the Advanced Mathematics program.

FY 1998-99 Increase due to outyear funding for the Miniature Air-Launched Decoy (MALD) program and Affordable Rapid Response Missile Demonstration.

(U) **Other Program Funding Summary Cost**:

	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Funding for Miniature Air-Launched Decoy PE 0603750D, Advanced Concept Technology Demonstration	0.5	3.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	361.1

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DATE February 1997

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Tactical Technology, PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Aeronautics Technology TT-07	2,100	14,880	18,000	19,500	8,000	30,011	30,000	35,648	Continuing	Continuing

(U) **Mission Description**: Aeronautics Technology efforts will address high payoff opportunities to dramatically reduce costs associated with advanced aeronautical systems or provide revolutionary new system capabilities for satisfying current and projected military mission requirements.

(U) A new family of Micro-Air Vehicles (MAVs) which are at least an order of magnitude smaller than current flying systems (less than 15 cm in any dimension) will be developed and demonstrated. The capability to accomplish unique military missions as diverse as covert imaging in constrained areas, biological-chemical agent detection and characterization, remote precision mines, and urban battlefield communications enhancement, will be stressed through an examination of a variety of vehicle concepts. The resulting capability should be especially beneficial in the emerging urban warfighting environment, characterized by its complex topologies, confined spaces and areas (often internal to buildings), and high civilian concentrations. The MAV program will focus on the technologies and components required to enable flight at these small scales, including flight control, propulsion and lightweight power, navigation and communications, building upon and exploiting numerous DARPA technology development efforts, including advanced communications and information systems, high performance computer technology, Microelectro-mechanical Systems (MEMS), advanced sensors, lightweight, efficient high density power sources, and advanced electronic packaging technologies.

(U) The feasibility of developing and demonstrating a family of Unmanned Tactical Aircraft (UTAs) will be investigated and an Advanced Technology Demonstration of one member of this family of UTAs will be conducted. This UTA will be called the Urban Combat Vehicle (UCV). It will be a small, inexpensive aircraft, capable of operating from austere land bases and air capable ships. The UCV will be able, with the assistance of a ground-based controller, to proceed to the target area, identify a potential target or targets, and release a loitering weapon or weapons. Either autonomously through target recognition, or through the assistance of a ground controller, the loitering weapon will precisely locate and destroy its target.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Initiated assessments of operational scenarios, candidate MAV configurations, and critical component technologies including four SBIR tasks. ($1.0M)
- Conducted Unmanned Tactical Aircraft (UTA) feasibility analyses and design trade studies. ($1.1M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-07

(U) FY 1997 Program:

- Conduct studies of Micro-Air Vehicle (MAV) systems and technologies; continue to explore and assess operational scenarios, systems configurations and component technologies. Initiate development of MAV systems, flight enabling technologies and critical technology components. ($2.9M)
- Conduct testing of emergent aerospace concepts. ($12.0M)

(U) FY 1998 Program:

- Initiate design and development of functionally diverse unpropelled and propelled MAV systems, employing alternative technology solutions, and satisfying user-identified critical military applications. Explore and demonstrate feasibility of key flight enabling technology component and subsystems. Continue evaluation of operational concepts. ($12.0M)
- Conduct detailed design, weapons integration, fabrication, and signature testing of two Urban Combat Vehicles (UCVs). ($6.0M)

(U) FY 1999 Program:

- Complete unpropelled MAV fabrication and initiate developmental flight testing. Continue propelled system development and fabrication. Continue exploration and demonstration of flight enabling technologies and subsystems. Initiate flight test planning for propelled systems incorporating operational templates, design flight capabilities, and mission characteristics. Prepare and release Broad Agency Announcement (BAA) for Advanced MAV Concept Definition. ($12.0M)
- Conduct flight testing, full up weapons system demonstration, and system performance evaluation of the UCV concept. ($7.5M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	10.0	10.0
Appropriated	0	12.0	N/A	N/A
Current Budget	2.1	14.9	18.0	19.5

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-07

(U) **Change Summary Explanation**:

FY 1996 Below threshold reprogramming to conduct Micro-Air Vehicle (MAV) and Unmanned Tactical Aircraft studies.
FY 1997 Below threshold reprogramming to continue MAV program.
FY 1998-99 Repricing of the MAV program and addition of the Urban Combat Vehicle (UCV) program.

(U) **Other Program Funding Summary Cost**: N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Logistics Technology TT-10	4,328*	18,333	25,738	27,665	10,633	10,000	0	0	0	N/A

* Additional funding for this program was in PE 0602301E, Project ST-11 ($4.1M).

(U) **Mission Description:** The Advanced Logistics Program will investigate and demonstrate technologies that will make a fundamental difference in transportation and logistics. The program will define, develop, and demonstrate fundamental enabling technologies that will permit forces and sustainment materiel to be deployed, tracked, refurbished, sustained, and redeployed more effectively and efficiently than ever before. Currently, this is accomplished using isolated, independent, and sometimes incompatible systems, processes and data. Therefore, the very rapid replanning and redirection necessary to support missions involving simultaneous local and major regional conflicts cannot be accomplished today. The Advanced Logistics Program will address these shortcomings and enable this significant capability to be developed. In addition, the project has enormous potential for cost savings through greatly improved management of transportation and logistics assets.

(U) Additionally, this program will develop automated, multi-echelon, collaborative logistical/transportation technologies that will provide warfighters with an unprecedented capability to monitor, rapidly replan and re-execute logistical support, even while assets are enroute to the theater. The Advanced Logistics Program will focus on three areas: 1) Development of a computer network infrastructure that allows distributed real-time visualization and interaction with all phases, elements and components of the military and commercial transportation infrastructure; 2) Development of applications providing a technology environment that allows warfighters to rapidly understand and assess the logistics and transportation implications of a crisis situation, to generate effective plans and courses of action, to monitor a plan's execution, and to use that information to re-plan; and 3) Automated systems that will enable significant efficiency improvements in transportation and logistics, such as monitoring the condition of assets and the infrastructure, the creation of "plan sentinels" to serve as an early warning system for plan deviations, and improved theater distribution. The capabilities from these three areas will be integrated to demonstrate an end-to-end system solution.

(U) The Advanced Logistics Program supports joint initiatives with the Defense Logistics Agency and is coordinated with other related logistics efforts within the DoD. As these technologies mature, they will immediately transition to other joint initiatives which include: the Defense Logistics Agency Logistics Research and Development (PE 0603712S), the Joint Logistics Advanced Concept Technology Demonstration (TT-11), and eventually to the Global Command and Control System (GCCS) and the Global Combat Support System (GCSS).

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Tactical Technology, PE 0602702E, Project TT-10

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Initiated development of a distributed logistics and transportation network including development of information manipulation and planning technologies to support planning, execution, monitoring and focused replanning throughout the logistics pipeline. ($2.3M)
- Initiated definition of technology requirements for data gathering and measurement of the logistics execution environment including data gathering technologies for semi-autonomous capture, search and retrieval of data in disparate defense and commercial logistics sources and advanced tagging/locating/ measurement sampling systems and software. ($2.0M)

(U) FY 1997 Program:

- Continue architecture development and demonstrate a distributed logistics planning, execution, and monitoring system concept to support inland military logistics planning/replanning from origin to port. ($6.0M)
- Conduct a feasibility demonstration of advanced technologies for logistics support planning, measurement sampling, and software systems. ($3.0M)
- Initiate proof of principle for advanced software data collection techniques (also referred to as knowledge rovers or intelligent software agents) that search the Global Information Infrastructure for relevant logistics information and data and return it to the user. Initiate development of multi-echelon collaborative logistical support technology that integrate planning, execution, monitoring and decision support systems for testing and fielding. Conduct concept formulation and initial utility demonstration of "plan sentinels" to detect plan deviations within a rapid replanning environment. Develop an integrated software framework that is reusable and reconfigurable. ($9.3M)

(U) FY 1998 Program:

- Demonstrate an integrated computer environment to support automated planning, execution and monitoring of a major force deployment from fort to port to ship load, including optimized scheduling and routing with minimal staging throughout the move. ($8.0M)
- Initiate development of plan deviation detection sentinels and predictive analysis to assist in identification of replanning opportunities. ($8.0M)
- Continue development of advanced software data collection techniques. Initiate development of a Dynamic Critical Items List for sustainment planning and execution. Continue development of multi-echelon collaborative logistical support technologies. Develop and demonstrate initial automated coarse-grained course of action evaluation that is linked to the war plan. ($9.7M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 2 Applied Research	Tactical Technology, PE 0602702E, Project TT-10

(U) FY 1999 Program:

- Demonstrate an integrated environment to support the planning, execution and monitoring of a major force deployment from point of debarkation through in-theater distribution, including automated infrastructure assessment and monitoring. ($10.0M)
- Develop and demonstrate the ability to negotiate the exchange of information between suppliers and buyers, including rapid, flexible item and item relationship catalogs. ($7.0M)
- Extend "plan sentinels" for automated deviation detection and triggering of the replanning processes. Continue development of a Dynamic Critical Items List for sustainment planning and execution. Develop and demonstrate automated medium grained course of action evaluation that is linked to the war plan. ($10.7M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	4.3	17.2	25.7	27.7
Appropriated	4.3	16.8	N/A	N/A
Current Budget	4.3	18.3	25.7	27.7

(U) **Change Summary Explanation**:

FY 1997 Increase reflects rephasing of the "plan sentinels" studies.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Joint Logistics ACTD TT-11	*	*	11,300	10,000	10,000	10,000	10,000	10,000	Continuing	Continuing

* The FY 1997 Joint Logistics ACTD effort was funded by the Army in PE 0603734A. The DARPA funding under this project continues the effort and expands the tools into a joint common operating environment.

(U) **Mission Description:** The Joint Logistics Advanced Concepts Technology Demonstration (JL ACTD) is a multi-phase program which will provide an experimental environment where logisticians can evaluate maturing tools and technologies for increased operational capability. Initial efforts will integrate existing tools that exploit near real-time logistics data sources operating within the Global Combat Support System (GCSS). Key data sources include Joint Total Asset Visibility (JTAV), Joint Personnel Asset Visibility (JPAV), and Global Transportation Network (GTN). This program will also provide a migration path for evaluating advanced technologies that are being developed by other programs such as the DARPA Advanced Logistics Technology Program (TT-10), the Battlefield Awareness and Data Dissemination ACTD, the Joint Force Air Component Commander (JFACC) Program, and the Advanced Joint Planning ACTD. The ACTD will provide logisticians the opportunity to assess the operational impact of emerging tools and technologies. Focus areas include maintaining asset visibility and control, monitoring real time execution of plans, and re-planning logistics operations to rapidly re-prioritize and redirect combat support. The ACTD will support CINC/JTF and Service/Agency logisticians across the entire operational spectrum -- mobilization, deployment, employment, sustainment and redeployment.

(U) **Program Accomplishments and Plan**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program: N/A

(U) FY 1998 Program:

- Define operational architecture and network requirements for employment of joint decision support tools for CINCs, Components, and Services that operate within the GCSS environment and exploit near real-time data feeds (JTAV, JPAV, GTN, etc.). ($3.3M)
- Integrate initial joint logistics tool sets and field at selected demonstration sites. ($6.5M)
- Demonstrate access within GCSS environment in a joint warfighting exercise. ($1.5M)

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(U) FY 1999 Program:

- Develop common user interfaces to multiple data bases (JTAV, JPAV, GTN, etc.) for query and presentation using advanced query mechanisms and visualization tools. ($3.0M)
- Expand tool set functionality focusing on CINC, Component, and Service needs and integrate within the GCSS environment. Continue fielding at selected demonstration sites. ($5.5M)
- Demonstrate multi-echelon interoperability in a joint warfighting exercise. ($1.5M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0*	0*	11.3	10.0
Appropriated	N/A	N/A	N/A	N/A
Current Budget	0*	0*	11.3	10.0

(U) **Change Summary Explanation**: *Funded by the Army in PE 0603734A.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Integrated Command and Control Technology, PE 0602708E, R-1 #17

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
High Definition Systems IC-03	44,395	59,672	37,000	40,000	39,000	39,000	0	0	0	N/A

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because it develops the technology and manufacturing capability for high definition displays and is important for virtually all DoD applications that involve visual and graphic information. Major components of this program include: projection, head mounted and direct view displays based on multiple technologies; development of equipment and components required to manufacture advanced display technologies, and prototype display systems for system evaluation. These efforts will establish a domestic technical capability and demonstrate the manufacturing capability of components necessary for military systems that capture, process, store, distribute and display high resolution images.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Continued development of flat panel and projection displays for mobile displays, and shipboard and landbased command and control centers. ($19.3M)
- Continued development of equipment and components to meet display cost and performance goals. This included efforts in patterning, film deposition and annealing, and field emission display materials and assembly tools, as well as reflective liquid crystal materials and phosphor technology development. ($17.1M)
- Developed system prototypes which leveraged earlier developed display technologies and incorporated integrated systems and intelligent interfaces. ($8.0M)

(U) FY 1997 Program:

- Continue development of next generation reflective and emissive mobile display technologies and laser based projection systems for command and control applications. ($17.5M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in field emission display materials, organic light emitting materials, reflective liquid crystal materials, phosphor technology development, and support for domestic display manufacturing infrastructure. ($29.1M)
- Continue development of system prototypes which leverage earlier developed display technologies and incorporate integrated systems and intelligent interfaces. ($13.1M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 2 Applied Research	R-1 ITEM NOMENCLATURE Integrated Command and Control Technology, PE 0602708E, Project IC-03

(U) FY 1998 Program:

- Continue development of next generation reflective and emissive mobile display technologies and systems for command and control applications, including laser based projection. ($9.2M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in printing and microreplication, field emission display materials, organic light emitting materials, phosphor technology development, and support for the domestic display manufacturing infrastructure. ($22.3M)
- Continue development of system prototypes which leverage earlier developed display technologies, particularly for mobile displays and incorporate integrated systems and intelligent interfaces. ($5.5M)

(U) FY 1999 Program:

- Complete development of next generation reflective and emissive mobile display technologies and continue development of displays for command and control applications, including laser projection displays. ($10.0M)
- Continue development of equipment and components to meet display cost and performance goals. This will include efforts in printing and microreplication, field emission display materials, organic light emitting materials, phosphor technology development and support for the domestic display manufacturing infrastructure. ($18.0M)
- Complete first generation integrated display systems and system prototypes for mobile applications. Continue development of large screen command and control system prototypes. ($12.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	48.0	45.0	45.0	45.0
Appropriated	48.7	59.7	N/A	N/A
Current Budget	44.4	59.7	37.0	40.0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia supplemental rescissions ($-.5M), reprogramming of SBIR funding to a separate PE, and minor below threshold reprogrammings.

FY 1998-99 Decreases reflect realignment of program priorities.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 2 Applied Research

R-1 ITEM NOMENCLATURE
Materials and Electronics Technology,
PE 0602712E, R-1 #18

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials and Electronics Technology	**227,848**	**213,843**	**192,192**	**236,730**	**257,672**	**265,039**	**314,596**	**335,063**	**Continuing**	**Continuing**
Materials Processing Technology MPT-01	119,071	117,527	103,822	123,181	124,350	127,927	161,127	174,327	Continuing	Continuing
Microelectronic Device Technology MPT-02	52,845	58,699	56,796	77,660	96,222	98,881	110,972	110,972	Continuing	Continuing
Cryogenic Electronics MPT-06	28,403	16,490	13,190	18,203	17,546	20,000	25,000	30,000	Continuing	Continuing
Military Medical/Trauma Care Technology MPT-07	27,529	21,127	18,384	17,686	19,554	18,231	17,497	19,764	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Applied Research Budget Activity because its objective is to develop technology related to those materials, electronics, and medical devices that make possible a wide range of new military capabilities.

(U) The Materials Processing Technology project (MPT-01) concentrates on the development of novel materials, materials processing techniques, and mathematical models and fabrication strategies for advanced structural and functional materials and components which will lower the cost, increase the performance, and enable new missions for military platforms and systems. Areas of concentration include exploitation of emerging processing approaches to tailor the properties and performance of structural materials and devices. This emphasis includes lightweight personnel protection, mesoscale machines for miniature devices, and ultra lightweight materials. The project also focuses on smart materials, sensors and actuators, functional materials and devices, and advanced magnetic materials for non-volatile, radiation hardened magnetic memories. Other areas of concentration include new materials concepts for portable power, protective coating materials to eliminate environmental hazards, infrared artificial dielectrics, development of bio-interface materials and methods, energy harvesting concepts, and frequency agile materials based on ferrite and ferroelectric oxides.

(U) The Microelectronics Device Technologies project (MPT-02) develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics and infrared devices. Areas of emphasis include high-performance analog-to-digital converters, military optical processors, novel optoelectronic

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devices and components, high temperature electronic devices, and high power electronics. This project includes a significant effort to develop advanced materials and device technology beyond the classical scaling limits of silicon device technology.

(U) In the Cryogenic Electronics project (MPT-06), thin film electromagnetic materials have reached a stage of development where specific applications can be identified in electronic devices and circuitry for military applications. Thin-film high temperature superconducting components packaged with cryogenic devices are being applied to radars, electronic warfare suites, and communications systems to enhance performance while reducing size and power requirements. Highly dependable and inexpensive cryocoolers (including thermoelectric coolers) are being developed for these applications, and expanded efforts will explore techniques to improve the performance of all solid state thermoelectric coolers as well as the overall cryogenic performance in applications ranging from communications to computing.

(U) Military Medical/Trauma Care Technology project (MPT-07) is an initiative to significantly improve far-forward battlefield trauma care. The project focuses on the human factors of advanced technology concepts in a front-line battlefield environment through development of body-worn monitors, field-portable digital imaging equipment, battlefield surgical simulation and high-fidelity imaging for ultrasound.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Materials Processing Technology MPT-01	119,071	117,527	103,822	123,181	124,350	127,927	161,127	174,327	Continuing	Continuing

(U) **Mission Description**: The major goals of this project are to develop novel materials, materials processing techniques, mathematical models and fabrication strategies for advanced structural and functional materials and components which will lower the cost, increase the performance and/or enable new missions for military platforms and systems.

(U) One important area of concentration is the exploitation of emerging processing approaches to tailor the properties and performance of structural materials and devices. Thrusts in this area include new concepts for lightweight personnel protection, mesoscale machines for miniature devices, and ultra lightweight materials for lowering the weight and increasing the performance of aircraft and spacecraft structures. Smart materials, sensors and actuators for the control of the aerodynamic and hydrodynamic behavior of military systems are being developed and demonstrated to increase performance and lower detectability of aircraft, helicopters and submarines.

(U) A second major thrust is the development of functional materials and devices. This includes advanced magnetic materials for high sensitivity, magnetic field sensors and non-volatile, radiation hardened magnetic memories with very high density, short access time, infinite cycle ability and low power. Frequency-agile materials based on ferrite and ferroelectric oxides will be developed for tuned filters, oscillators and antennas. New materials and concepts for increasing the availability of portable power to the soldier are also being investigated as are substitute protective coating materials which eliminate environmental hazards. Infrared Artificial Dielectrics (IRADs) are a new class of infrared materials having an emissivity that can be fully engineered for different spectral bands. For example, it may be possible for IRADs to camouflage hot objects from passive infrared sensors operating in the common 8-to-12 micron band.

(U) The unique characteristics of biologically derived devices will be exploited through the understanding and control of the structure and chemistry of the interface between man-made and biotic materials. For example, we will develop bio-interface materials and methods for preventing pathogens (biological warfare agents) from entering a warfighter's body and, once in the body, prevent them from causing disease. Approaches include advanced biomaterial barriers and elimination techniques to prevent pathogen entry and augment the warfighter's immune response to pathogens.

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(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Structural Materials and Devices. ($32.3M)
  - Demonstrated full-scale rapid densification of carbon-carbon composite components.
  - Demonstrated a five-fold improvement in the life of the roll reaction control (RRC) valve bearings on the AV-8B Harrier aircraft due to the upgrade of the metal bearings with ceramic hybrid bearings.
  - Validated the Resonant Ultrasonic Inspection technique for ceramic rolling elements through beta site testing at a commercial ball bearing finisher.
  - Demonstrated production of voided and foamed aluminum and titanium core materials for ultra lightweight panels.
  - Demonstrated low cost aluminum-beryllium aerostructure fabrication processes.
  - Demonstrated reduced mean-time-between-failure (MTBF) associated with the upgrade of glass optical domes to spinel domes used in the Angle Rate Bombing Set (ARBS) of the AV-8B Harrier aircraft.
  - Demonstrated the use of X-ray tomography and developed software to generate computer aided design (CAD) files from solid objects compatible with the requirements of solid freeform fabrication.
  - Developed the machine capability to produce silicon nitride components using the fused deposition method with silicon nitride powder loaded wax filaments.
  - Demonstrated the capability to fabricate molds for slip casting structural ceramics and for producing low cost resin transfer molding tooling using 3-D printing technology.
  - Designed an advanced polarization preserving fiber optic connector.
  - Developed a chemical vapor deposition (CVD) process for the fabrication of particulate and chopped fiber reinforced composites with a 10X increase in composite growth rate over normal CVD processing; demonstrated the utility of the fabricated composites for the die casting of copper alloys.
  - Developed feedback control methods for plasma sprayed metal matrix composites.
  - Developed new casting practices which will reduce the emissions of foundries with focus on characterization of emissions in current casting processes, core and mold making technology, metal melting treatments and handling, sand reclamation, and emissions control.
- Smart Materials and Actuators. ($20.8M)
  - Demonstrated the application of smart materials to reconfigurable machines and tooling hardware.
  - Analyzed smart materials applications for submarines.
  - Demonstrated material sensor and activator components manufacturability utilizing piezoelectric ceramics and electrostrictors.

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- Completed wind tunnel testing of first iteration shape adaptive F-18 wing model.

- Functional Materials and Devices. ($40.3M)
  - Demonstrated prototype multichip modules (MCM) with laminate technology roll-to-roll processing.
  - Demonstrated a prototype MCM for a missile guidance section using a bare die on a laminate substrate and electronically validated its performance.
  - Developed simulation codes for the physics of vapor deposition and validated on industrial processes.
  - Demonstrated a process to produce elastomeric electrorheological materials for acoustic wave filtering applications.
  - Demonstrated large area, high deposition rate chemical vapor deposition (CVD) of diamond substrates.
  - Identified processing approaches for manufacturing high thermal conductivity (>10W/K-cm), low-cost (<$1/carat) diamond for thermal management of defense electronics.
  - Initiated the demonstration of thermal management diamond in specific defense applications (e.g., high power transmit-receive modules, electronic warfare (EW) systems).
  - Developed stable contacts for high temperature, high power semiconductors.
  - Demonstrated high yield, large area processing of thin film, high temperature superconducting devices.
  - Developed giant magneto-resistive (GMR) films with enhanced electrical characteristics and enhanced magneto-resistance ratio for higher sensitivity magnetic devices.
  - A model magnetic memory cell design was completed.
- Energy and Environmental Sciences. ($17.7M)
  - Designed and initiated construction of a hydrothermal oxidation system for shipboard excess hazardous material disposal.
  - Demonstrated more environmentally sound production processes for printed wiring boards.
  - Designed sensors and control models for the intelligent processing of materials to improve the reliability of thermal barrier coatings for turbine engine airfoils and demonstrated these on a production scale reactor.
  - Initiated studies of advanced erosion/corrosion resistant thin film coatings.
  - Established and demonstrated process parameters for the manufacture of copper-indium diselenide (CIS) photovoltaic solar cells in production scale efficiencies of over 8% (photons in to electrons out).
- Bio Detection & Identification; BW Information Technologies; BW Immediate Response. ($8.0M)
  - Developed integration technology to insert up-converting phosphors into existing biological warfare agent sensors.
  - Demonstrated feasibility of an aflatoxin biosensor.
  - Initiated design phase of microfabricated polymer bilayer air-fluid sampling inlet.

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- Initiated research to identify, purify, and crystallize target enzymes for inhibition of spore germination.
- Developed reference architecture for smart messages system.

(U) FY 1997 Program:

- Structural Materials and Devices. ($32.7M)
  - Demonstrate a 2X increase in mean-time-between-failures (MTBF) associated with the replacement of carbon engine starter oil face seals on aircraft with ceramic face seals.
  - Demonstrate novel, low cost processing approaches for ceramic composites for use in gas turbine engines.
  - Demonstrate production of titanium components using laser sintering techniques.
  - Demonstrate production of cast aluminum-beryllium components.
  - Demonstrate secondary processing and joining of structurally porous ultra lightweight panels.
  - Demonstrate the capability to produce ceramic components with complex geometry and dimensional tolerances and mechanical properties comparable to mass manufactured advanced ceramics using Jet Printer technology (3-D printing).
  - Develop a new solid freeform build method for ceramic components based on layer-by-layer photolithography utilizing either large area liquid crystal display or a light emitting diode display technology for electronically programmable photomasks.
  - Determine the feasibility of using new processing approaches (e.g., solid freeform fabrication) for controlling the dimensional tolerances, microstructural and mechanical properties, and affordability required for components and mesoscale machines.
  - Test reconfigurable machines and tools in shop floor beta test sites.
  - Determine the performance characteristics of low cost, damage tolerant fibrous monolith components in engine environments.
  - Demonstrate control of physical vapor deposition metal-matrix processing and extend process control models to physical vapor deposition of metal coated fibers in 60 filament bundles.
  - Demonstrate the fabrication of nanostructured, hard carbon coatings with high adhesion, low friction, high hardness and high wear resistance.
  - Determine the economic viability of Templated Grain Growth (TGG), a process by which solid phase epitaxy of crystallographically oriented seeds on near net shaped polycrystalline components is used for growth of single crystal-like oxides.
- Smart Materials and Devices. ($22.3M)
  - Demonstrate a fabrication process for microintegrated smart materials.

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- Demonstrate vibration reduction by a factor of ten in machine tools via specially designed sensor/actuator elements to enhance machining tolerances.
- Construct fully integrated hydro-acoustic noise suppression tile.
- Conduct wind tunnel test of second generation shape adaptive F-18 wing model.
- Demonstrate vibration suppression in subscale helicopter blades in hover stand and wind tunnel tests.

• Functional Materials and Devices. ($43.7M)
- Complete development of a plasma/ion etch numerical simulation.
- Demonstrate predictive capability of high-pressure, low-order, chemical vapor deposition models and demonstrate feedback control to a desired wafer state.
- Demonstrate intelligent processing of large area chemical vapor deposition (CVD) of diamond with production costs of $1/carat.
- Demonstrate the advantages of thermal management diamond in the performance of defense electronic systems or subsystems.
- Grow single crystal boules for two inch diameter silicon carbide semiconductor wafers by scaling up the reactor and developing larger seed crystals.
- Demonstrate high temperature superconducting technology with greater than fifteen square inch format and greater than eighty percent yield.
- Demonstrate large area deposition of giant magneto-resistive (GMR) materials.
- Demonstrate prototype GMR magnetic memory cell and spin transistor memory cell using magnetic multilayers.
- Begin development of candidate polymers using advanced lithography techniques for infrared artificial dielectrics (IRADs).
- Initiate effort on nanophase magnetic materials.

• Energy and Environmental Sciences. ($18.8M)
- Demonstrate a hydrothermal oxidation pilot plant for the destruction of shipboard excess hazardous materials.
- Demonstrate novel recycling/reclamation techniques for disposal of scrap polymer matrix composites.
- Demonstrate intelligent processing of thermal barrier coatings yielding reliable coatings which increase turbine engine inlet temperatures by up to 200 degrees F, with a commensurate increase of 10-15% in thrust.
- Develop advanced erosion/corrosion resistant thin film coatings for military applications.
- Demonstrate high yield, pilot scale production (1.5 megawatt/year) of high efficiency (10%) copper-indium diselenide (CIS) solar cells on flexible substrates; test in a military environment.

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(U) FY 1998 Program:

- Structural Materials and Devices. ($27.9M)
  - Demonstrate low cost titanium and superalloy component fabrication processes.
  - Demonstrate uniformly bonded face sheet attachment on ultra lightweight foamed metal structures.
  - Demonstrate a 5x reduction in prototyping time (print-to-part) for ceramic and metal gas turbine engine components utilizing solid freeform manufacturing.
  - Demonstrate laser workcell at a beta test site.
  - Establish approaches for breakthrough gains in personnel protection performance (e.g., >100% from current capabilities for 7.62 mm armor piercing (AP) round) through the application of innovative materials, materials processing and phenomenological modeling of multicomponent materials systems.
  - Build a high precision silicon nitride roll gimbal and pitch shaft for an infrared (IR) seeker utilizing Shaped Deposition Manufacturing (SDM), which combines additive and subtractive processing.
  - Select and begin a specific mesoscale machine demonstration of interest to DoD (e.g., miniature air sampler, catalytic air purifier, etc.).
  - Evaluate Al-Be F-15 rudder spar.
  - Evaluate structurally porous ultra light weight aircraft panels.
- Smart Materials and Actuators. ($20.7M)
  - Demonstrate full size smart material active helicopter blade structures and acoustic noise suppression structure on a rotor test stand.
  - Evaluate actuation potential of magnetoelastic and magneto-shape memory transducer materials.
  - Evaluate high performance electroceramic actuator fabrication processes.
  - Demonstrate applicability of a smart shape adaptive wing to vortex destabilization concept in hydro applications.
  - Design, build, test and evaluate high power laminated actuator stacks for smart defense structures utilizing Computer Aided Manufacturing-Laminated Engineering Materials (CAM-LEM) solid freeform fabrication (SFF) capability.
- Functional Materials and Devices. ($37.5M)
  - Demonstrate a prototype giant magneto-resistive (GMR) magnetic memory array and spin transistor memory cell array using magnetic multilayers.
  - Design and build a very high sensitivity magnetometer.
  - Continue polymer development using advanced lithography techniques for infrared artificial dielectrics (IRADs).

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- Initiate effort to reduce loss tangent in ferrites and ferroelectric oxides for frequency agile rf components.
- Demonstrate a switched circulator and phase shifter using thick film ferrites.
- Select model systems for establishing the structure and chemistry of biotic/abiotic interfaces providing the capability to design biological devices of interest to DoD (e.g., sensors, smart membranes, actuators, etc.).
- Demonstrate proof of concept for templated vapor phase single crystal growth on projected x-ray interference patterns of atomic dimensions.

• Energy and Environmental Sciences. ($17.7M)
- Demonstrate the utility of advanced erosion/corrosion resistant thin film coatings at a military site.
- Extend concepts of intelligent processing of thermal barrier coatings to complex multilayer systems capable of an additional 200 degrees F in turbine inlet temperature (10-15% additional thrust) without sacrificing reliability.
- Develop balance-of-plant and packaging for a direct oxidation fuel cell replacement for military standard batteries.
- Demonstrate that full scale, intelligent processing of copper-indium diselenide (CIS) solar cells yields both performance and cost (<$1/watt) suitable for use of flexible photovoltaics in military operations.
- Develop energy harvesting and storage concepts for unattended devices.

(U) <u>FY 1999 Program</u>:

• Structural Materials and Devices. ($34.4M)
- Fabricate and test materials and materials systems concepts designed to significantly improve personnel protection performance (e.g., >100% from current capabilities for 7.62 mm armor piercing (AP) round), dramatically increasing protection for the individual soldier.
- Demonstrate solid freeform fabrication of titanium forging blanks.
- Demonstrate spray forming of superalloy forging billets.
- Demonstrate the use of Solid Freeform Fabrication to upgrade distressed turbine vanes in man-rated gas turbine engines with ceramic composite components of high reliability.
- Demonstrate the construction and performance of a prototype mesoscale machine.

• Smart Materials and Actuators. ($22.6M)
- Demonstrate vortex wake reduction for submarines using smart materials.
- Demonstrate submarine acoustic noise reduction using smart material tiles.
- Demonstrate a shape adaptive fighter inlet.

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- Demonstrate fluid flow in an active submarine model.

- Functional Materials and Devices. ($44.0M)
  - Demonstrate high speed, radiation hard, medium density, non-volatile magnetic memory utilizing magnetic multilayers.
  - Demonstrate very high sensitivity magnetometer and gradiometer for localization of magnetic anomalies.
  - Expand the Solid Freeform Fabrication program to demonstrate a new process for the fabrication of silicon carbide (SiC) devices using rapid tool-less vapor deposition processes.
  - Complete polymer development for infrared artificial dielectrics (IRADs).
  - Demonstrate a loss tangent less than 0.002 in hybrid ferrite/ferroelectric frequency agile filters.
  - Demonstrate a voltage controlled oscillator (VCO) with an octave tuning range and low loss.
  - Demonstrate control of the biotic-abiotic interface for a specific biological device of interest to DoD.
  - Demonstrate scale-up capability for single crystal growth utilizing x-ray interference patterns to template crystal growth.
- Energy and Environmental Sciences. ($22.2M)
  - Demonstrate a low temperature, packaged direct oxidation fuel cell for soldier applications.
  - Demonstrate alternative energy sources for soldier microclimate cooling and for portable battery chargers.
  - Demonstrate energy harvesting from ambient sources for unattended sensor applications.
  - Complete demonstration and insertion of advanced erosion/corrosion resistant thin film coatings in military systems.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	122.7	110.2	137.4	142.5
Appropriated	126.0	116.3	N/A	N/A
Current Budget	119.1	117.5	103.8	123.2

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(U) **Change Summary Explanation**:

FY 1996	Decrease reflects inflation savings, ($-2.5 million) termination of polymer matrix composite effort ($-4.1 million) and minor program repricing ($-.3 million).
FY 1997	Increase reflects minor program repricing.
FY 1998-99	Decreases reflect transfer of biological warfare defense program to PE 0602383E and rephasing of the planned requirements for this project.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microelectronic Device Technologies MPT-02	52,845	58,699	56,796	77,660	96,222	98,881	110,972	110,972	Continuing	Continuing

(U) **Mission Description**: This project develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics, and infrared devices. Areas of emphasis include high performance analog-to-digital converters (ADCs), military optical processors, novel optoelectronic devices and components, high temperature electronic devices and high power electronics. This microelectronics development project develops and demonstrates advanced microelectronics technology for DoD critical needs. Technologies developed in this project are performance driven and exceed commercial capabilities. This project includes a significant effort to develop advanced material and device technology beyond the classical scaling limits of silicon device technology.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Developed heterojunction bipolar transistor process, device, and design technologies for application in high-speed analog-to-digital converters, digital-to-analog converters, multiplexers, and demultiplexers. ($7.2M)
- Delivered the first-generation of hardware and software for advanced image processing. ($6.3M)
- Completed development of advanced electronic neural network technologies for target tracking and recognition applications. ($6.5M)
- Developed critical materials, processes, and device technologies for .25µm silicon-on-insulator semiconductor fabrication. ($8.5M)
- Developed optoelectronics technologies to enable cost-effective fabrication and integration of module subassemblies for digital optoelectronic processors, bus and backplanes, and serial/parallel input/outputs. ($23.7M)
- Initiated efforts to design radio frequency photonic components for transmission of millimeter waves and microwaves. ($.6M)

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(U) FY 1997 Program:

- Complete hardware/software integration for advanced vision system, and demonstrate image recognition. ($8.5M)
- Demonstrate functionality and operation of high performance optoelectronic, digital processor prototype and develop advanced optoelectronic fabrication approaches and subassembly component technologies. ($18.9M)
- Develop component and fabrication technologies for radio frequency photonic components for application in millimeter wave and microwave transmission. ($2.4M)
- Initiate efforts to develop advanced digital-based radar receiver processor components based on high speed semiconductor technologies, such as heterojunction bipolar transistors (HBT). ($5.8M)
- Develop high speed mixed signal packaging environment and integration approaches for Analog to Digital Converter (ADC) processor elements. ($7.7M)
- Develop common complementary metal oxide semiconductor/silicon-on-insulator (CMOS/SOI) materials requirements to support low power electronics and radiation hardened performance requirements. ($2.7M)
- Advanced Microelectronics - Choose candidate multilayer semiconductor technologies; choose initial $(150nm)^2$ scale transistor configurations; and select candidate high throughput 25 nm patterning technologies. ($10.1M)
- Initiate efforts to extend high performance mixed signal device technology to geometries below 0.18 micron. ($2.6M)

(U) FY 1998 Program:

- Advanced Microelectronics - Choose candidate interconnect/stacking strategies. ($2.5M)
- Develop High Power Electronic Power Switching Devices in the 250°- 350°C range. ($2.0M)
- Develop solid-state electronic switches operating at current levels of at least 1000 A and voltage levels of at least 2500 V at a switching rate of at least 150 KHz, while maintaining a voltage drop of less than 0.6% of the rated voltage, and operate at ambient temperatures of at least 250°C. ($5.0M)
- Advanced Microelectronics Devices - Develop switching/amplifying devices with 25nm minimum features for terascale (3-dimensional) integrated circuitry; operating parameters include transconductance greater than 100 S/m and power-delay product less than 100aJ. ($8.0M)
- Advanced Microelectronic Technology - Develop non-conventional patterning technology for terascale integrated circuitry. Minimum feature size down to 25nm and throughput greater than 1 cm^2/second with overlay and feature size control consistent with requirements for terascale integrated circuitry. ($6.3M)
- Digital Radar Receiver Processor - Continue efforts to develop advanced digital-based processor components based on high speed semiconductor technologies, such as heterojunction bipolar transistors. ($10.0M)

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- A/D Converters - Develop integrated CAD tool set for high speed designs and demonstrate high speed analog-to-digital prototype. ($3.0M)
- Sonoelectronics - Initiate development of highly-effective sonoelectronic actuators and transducers that can be integrated directly with silicon VLSI circuits. ($8.0M)
- VLSI Photonics - Demonstrate feasibility of integration of small arrays (4x4) Vertical Cavity Surface Emitting Lasers with detectors, and identify degradation mechanism for polymer/small molecule lasers and demonstrate photopumped lasing. ($12.0M)

(U) FY 1999 Program:

- Advanced Microelectronics - Characterize candidate 25 nm transistors $(150nm)^2$ total area and establish process sequence for chip for proof of principle demonstration. ($8.1M)
- Advanced Microelectronics Process and Integration Technology - Develop feedback process control systems which integrate design and manufacturing to decoupling manufacturing cost from production volumes. ($16.6M)
- Digital Radar Receiver Processor - Develop Advanced digital processor components. ($10.0M)
- A/D Converters - Complete prototype demonstration. ($1.0M)
- Continue development of High Power Electronic Switching Devices. ($2.0M)
- Integrate High Power Electronic Switches with smart control circuits to form modules that sense and control the instantaneous state of high-power waveforms, and investigate the interaction of these modules with nonlinear load circuits, particularly large ac induction motors. ($4.0M)
- VLSI Photonics - Demonstrate integrated 8x8 VLSI photonics chip (laser, detector and electronics) and optoelectronic modeling tools compatible with electronic CAD tools and demonstrate the feasibility of using molecular self-assembly techniques to position optoelectronic devices with high precision on silicon circuits. ($20.0M)
- Sonoelectronics - Incorporate transducers in new acoustic passive and active arrays, particularly acoustic imaging sensors, weapons, and catalytic drivers, and study the phenomenology associated with the interaction of these arrays with chemical and biological matter. ($16.0M)

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(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	62.2	71.8	87.2	95.4
Appropriated	60.7	66.7	N/A	N/A
Current Budget	52.8	58.7	56.8	77.7

(U) **Change Summary Explanation**:

FY 1996 Decrease due to Bosnia supplemental rescission, SBIR transfer to PE 0605502E, and program restructuring.

FY 1997 Decrease reflects rephasing of the A/D converter integrated CAD design tool set from FY 1997 to FY 1998.

FY 1998-99 Decrease reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Cryogenic Electronics MPT-06	28,403	16,490	13,190	18,203	17,546	20,000	25,000	30,000	Continuing	Continuing

(U) **Mission Description**: Thin film electromagnetic materials have reached a stage of development where specific applications can be identified in electronic devices and circuitry for military systems. Films are deposited and patterned to form electromagnetic components in ways that are similar to, and compatible with, the processes of conventional semiconductor manufacturing. Such electromagnetic components, as well as complementary metal oxide semiconductors (CMOS), work best at lower temperatures, so that cryogenic packaging generally will be required for highest performance. Thin-film high temperature superconducting (HTS) components packaged with cryogenic devices are being applied to radars, electronic warfare suites, and communications systems to enhance performance by more than an order of magnitude while reducing size and power requirements. Particular demonstrations include an upgraded ship-defense radar (SPQ-9B) with 100X greater detectability of missiles in littoral clutter, and a switchable filterbank with 24 individually tuned high-performance filters to suppress Electronic Warfare (EW) saturation in radar warning receivers. Highly dependable and inexpensive cryocoolers (including thermoelectric cryocoolers) are being developed for these applications, and expanded efforts will explore techniques to improve the performance of all solid state thermoelectric coolers as well as the overall cryogenic performance in applications ranging from communications to computing.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- High Temperature Superconductors/Analog and Digital Applications ($13.7M): In this final year of the HTS Program, components were evaluated for integration into military avionics.
  - Continued integration of 24-element filterbank with refrigerator for application to F-15 aircraft.
  - Evaluated cryo-radar with HTS stabilized oscillator (STALO), at the Naval Research Laboratory (NRL) Chesapeake Bay Facility.
  - Completed funding for Consortium for Superconducting Electronics.
  - Continued development of a high-performance 8x8 asynchronous transfer mode (ATM) cryogenic switch in a wide area network.
  - Developed simultaneously switchable and tunable high temperature superconducting (HTS) filters, preserving low insertion loss and high quality factors.
  - Examined applicability of 2nd generation HTS filters to interference reduction in communications sets, particularly SINCGARS radios.

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- Developed a Broadband Waveform Generator incorporating high temperature superconducting (HTS) Josephson Junction array for advanced radar applications.
- Developed small HTS magnets for energy storage and mine countermeasures.

• Cryogenics Technologies. ($14.7M)
- Developed and began testing of small/inexpensive reliable cryocoolers.
- Developed electronic devices and components optimized for cooled operation.
- Initiated applications demonstrations with integrated cryocoolers and temperature-optimized components.
- Militarized several small low-cost cryocoolers for insertion into radar and Electronic Countermeasures (ECM) systems.
- Developed a miniaturized cryopackage for a High Stability Cryo-stabilized oscillator (STALO) for Airborne Radars.

(U) FY 1997 Program:

• Cryogenics Technologies. ($16.5M)
- Continue fabrication of cryo-radar, using HTS components and upgraded conventional components such as driver and active array, for final demonstration in FY 1998 with a simulated Naval scenario.
- Upgrade HTS switchable filter sets with tunable filters, for simpler construction and operation in aircraft Electronic Countermeasures (ECM) suites.
- Evaluate results of cryo-crossbar switch and asynchronous transfer mode (ATM) efforts. Determine most appropriate insertion for digital systems employing HTS devices as well as cryo-complementary metal oxide semiconductors (CMOS).
- Determine most important communications applications for cryo-components.
- Extend performance of "Manatee" signals intercept receiver to other frequency regimes, notably Global System for Mobile Communications (GSM).
- Continue funding wire development efforts for magnet demonstrations, in application to mine detonation in littoral scenarios, and compact travelling-wave tubes (TWTs).
- Develop ultra-high Q thin-film filters for use in SINCGARS and other communications sets.
- Evaluate advanced thermoelectric materials with significantly improved figure of merit including quantum well and multilayer structures.

(U) FY 1998 Program:

• Cryogenics Technologies. ($9.2M)
- Demonstrate, at an appropriate facility, a fully functional Cryo-Radar, with 108 dB dynamic range, 20 dB

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greater than present performance, showing capability to detect targets over that range and an ability to address the defense of surface ships to attacking missiles.
- Demonstrate the ability of cryo-filterbanks to provide Electronic Counter-Countermeasures (ECCM) for aircraft receivers, in a scenario to be developed by the Air Force.
- Demonstrate an improved analog to digital (A/D) converter employing cryogenic components.
- Demonstrate low-cost (less than $2500), highly reliable (greater than 30,000 hr) Sterling cycle cryocooler that delivers 5 watts at 80K with less than 200 watts of total power.

• Thermoelectric Materials and Devices. ($4.0M)
- Demonstrate a thermoelectric cooler that will provide a reduction in temperature greater than 50°C in a single stage.

(U) FY 1999 Program:
• Cryogenics Technologies. ($12.2M)
- Insert cryogenic packages in communication transceivers which mitigate electromagnetic interference effects.
- Demonstrate digital waveform generation and signal processing using superconducting quantum devices.
- Demonstrate pulse tube or Sterling cycle cryocooler costing less than $1,500 in quantities of 1,000 with greater than 40,000 hr mean time before failure that delivers 5 watts of cooling at 70K with an input power of 150 watts or less.

• Thermoelectric Materials and Devices. ($6.0M)
- Demonstrate thermoelectric coolers that can achieve 100°C cooling in less than three stages as compared to the current seven stages.
- Demonstrate potential benefit of efficient power generation from thermoelectric devices operating at high temperature (>500°C).

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	12.0	9.8	11.2	10.2
Appropriated	30.9	16.5	N/A	N/A
Current Budget	28.4	16.5	13.2	18.2

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(U) **Change Summary Explanation**:

FY 1996 Decrease reflects minor program repricing.
FY 1998-99 Increases reflect expansion of cryocooler effort to include advanced thermoelectric materials.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Military Medical/Trauma Care Technology MPT-07	27,529	21,127	18,384	17,686	19,554	18,231	17,497	19,764	Continuing	Continuing

(U) **Mission Description:** The objective of this project is to revolutionize far-forward battlefield trauma care. The project recognizes that planned downsizing of U.S. forces creates new pressures to ensure force readiness, skill mix, and effective joint doctrine at a time when battlefield casualties carry both strategic importance and tactical relevance. A review of combat casualty care has shown: (1) that 90% of combat deaths occur in the zone of close combat prior to medical or surgical intervention; (2) that 50% of these deaths are preventable with immediate, effective, correct medical treatment; (3) that casualty location is a continuing battlefield problem; and (4) that less than 5% of U.S. Army active-duty physicians have treated combat casualties.

(U) The DARPA Combat Casualty Care program has two major segments: (1) Advanced Biomedical Technology (ABT) and (2) Ultrasonic Diagnostic Imaging. The ABT segment exploits DARPA's unique leadership role in the electronics and information sciences to project advanced medical and surgical care into the far-forward battlefield area to effect early, successful, clinical intervention. In one thrust, this program will develop lightweight personnel status monitors (PSMs) permitting remote non-invasive clinical diagnosis, casualty localization, and friend or foe identification. The PSM, which would be worn by all soldiers as part of their combat uniforms, is further augmented with low power, secure, wireless communications and a Global Positioning Satellite system (GPS). The PSM would monitor the soldiers' clinical vital signs continuously, but would remain otherwise passive unless either queried by an operational commander or the soldiers' vital signs departed from established clinical norms.

(U) The ABT program will also develop the technology base for early far-forward medical/surgical intervention. Hemorrhage will be controlled by projecting the expertise of a surgeon with remote telepresence surgery. Once early surgical stabilization has been achieved, the patient will be evacuated in a critical care life support for trauma and transport pod (LSTAT) which will function like an autonomous single-patient hospital intensive care unit.

(U) In a third thrust, the ABT program will exploit advanced simulation technology to improve the training of battlefield health care providers and to ensure skill currency. The objectives of this effort are to provide for the virtual representation of human structure and function; ensure near-seamless transition from training to clinical practice; and to permit simulation of combat-casualty medical care within the framework of operational battlefield requirements. The broader impact of whole-body virtual simulation on medical education programs will allow military

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medical students to integrate traditionally separate academic disciplines and dramatically reduce the need for human cadavers or live animal wounding. New technologies for presenting information and training scenarios will be developed using human interface technologies. Virtual reality was used to prototype medical environments, such as mobile operating rooms, critical care life support for trauma and transport pod (LSTAT) and instruments/equipment inserted into casualty care simulations.

(U) The Ultrasonic Diagnostic Imaging segment will develop high-fidelity diagnostic imaging, particularly in biomedical applications of ultrasound. For example, in conventional ultrasound imaging the medium (i.e., human tissue) is inhomogeneous and scatters the signal, which blurs the image. The processes for developing high-resolution imaging will build upon the emerging technology of adaptive acoustics, the displays of which are intuitive and easily interpreted by the combat medic and physician.

(U) In FY 1996, DARPA concluded funding efforts in advanced healthcare informatics. This thrust was developing technology for an advanced healthcare information infrastructure to support the trauma care technology base.

(U) This work does not duplicate any efforts of the Military Services or the National Institutes of Health. A Memorandum of Agreement exists between the Army Medical Department and DARPA.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Advanced Biomedical Technology. ($16.8M)
  - Developed a specialty version of the Personnel Status Monitor (Ranger Overwatch PSM) with temperature, heart rate and motion sensors for insertion into Army Ranger training exercises.
  - Completed first prototype limb trauma simulator and delivered to U.S. Army Special Operations Command (USASOC) Medical Training facility.
  - Completed design and feasibility study to incorporate trauma simulator into the medic training on the virtual battlefield at the Dismounted Warrior Battle Lab (DWBL).
  - Completed 7 degrees of freedom (DOF) end-effectors and wireless communication packages for Remote Telepresence Surgery System.
  - Completed and delivered first prototype of life support for trauma and transport (LSTAT).
- 3-D Ultrasound Technologies. ($2.1M)
  - Developed prototype battlefield/trauma ultrasonic imager technology (using a 2D array equivalent) for 3D interpretation of body structures for insertion into Bosnia as a battlefield tele-ultrasound unit.

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- Continued development of processing techniques taken from synthetic aperture radar to determine those features which are pertinent to the ultrasonic imaging problem. Began testing algorithms which could mitigate the contribution of multiple scattering sites to image degradation.

- Healthcare Information Infrastructure. ($6.2M)
  - Integrated models of combat doctrine and knowledge-based decision support tools (combat casualty protocols and guidelines) in support of combat medics and physicians.
  - Demonstrated hands-free capture of patient data under battlefield conditions.
  - Demonstrated integration of battlefield electronic patient record with peacetime care systems.
- Bio Detection and Identification. ($2.4M)
  - Continued development of ionization source and curved-field reflectron for tiny time-of-flight mass spectrometer.
  - Conducted preliminary exploration of approaches to transect and characterize the induced genetic changes in stem cells or their derivative lineages for the purpose of potential defense against biological weapons.

(U) <u>FY 1997 Program</u>:

- Advanced Biomedical Technology. ($16.6M)
  - Develop and demonstrate respiration sensor for Personnel Status Monitor (PSM) and validate medical algorithm.
  - Develop sensate liner for identifying penetrating wounds.
  - Incorporate full haptic interface (sense of touch) into limb trauma simulator, phase one of organ system surgical simulation, and integrate medic simulation into Dismounted Warrior Battle Labs (DWBL).
  - Develop interchangeable surgical tools for remote telepresence surgery and explore methodology for motion compensation (e.g., beating heart); insertion of beta version of Life Support for Trauma and Transport (LSTAT).
  - Integrate micro-miniaturized components (ventilation, oxygen generator, monitors, power units) into beta version LSTAT with canopy. Demonstrate 3rd generation design of LSTAT which is NATO compatible.
- 3-D Ultrasound Technologies. ($4.5M)
  - Continue to develop and implement the techniques of adaptive acoustics to ultrasonic imaging, utilizing 2-D sensor arrays and image processing.
  - Demonstrate battlefield tele-ultrasound unit in Bosnia, linking an Army field hospital in Bosnia with an Army hospital in Germany.

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(U) FY 1998 Program:

- Advanced Biomedical Technology. ($11.4M)
  - Complete sensor and algorithm development for PSM system, developing and integrating the sensate liner of microsensors into the system. Transition PSM to Army.
  - Complete and deliver Remote Telepresence Surgery system to the Uniformed Services University of the Health Sciences with enhanced 6 degrees of freedom (DOF) manipulators.
  - Develop 3rd generation virtual simulation of battlefield injuries to solid organs as well as extremities with full physiologic responses such as bleeding and muscle twitching; integrate wound simulators into medic representation on virtual battlefield at Dismounted Warrior Battle Labs (DWBL).
- 3-D Ultrasound. ($7.0M)
  - Continue to develop 2-D array ultrasound transducer.
  - Continue digital signal processing (DSP) for high-resolution, high signal-to-noise (S/N) ultrasound image.

(U) FY 1999 Program:

- Advanced Biomedical Technology. ($10.1M)
  - Continue development of enhanced dexterity micro manipulators.
  - Continue exploration of unconventional actuators (artificial muscles, MEMS, etc.).
  - Complete transition of telepresence surgery and casualty simulation technologies to the services.
- 3-D Ultrasound Technologies. ($7.6M)
  - Complete ultrasound enhancements for scattering, deaberration, and beam forming.
  - Develop and test field-portable, hand-held ultrasonic imager.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	29.1	26.7	31.2	37.7
Appropriated	24.3	18.8	N/A	N/A
Current Budget	27.5	21.1	18.4	17.7

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(U) **Change Summary Explanation**:

FY 1996 Increase reflects Bio Detection and Identification ($2.3 million), minor repricing ($1.3 million), inflation savings ($-.1 million), and Small Business Innovative Research (SBIR) transfer to PE 0605502E ($-.3 million).

FY 1997 Increase reflects minor repricing of the Advanced Biomedical Technology program.

FY 1998-99 Decrease reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E, R-1 #46

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Electronics Technologies	**389,610**	**360,288**	**277,044**	**282,668**	**313,332**	**286,460**	**272,240**	**275,679**	**Continuing**	**Continuing**
IR Focal Plane Array (IRFPA) MT-03	39,493	23,076	9,000	11,000	3,000	0	0	0	0	N/A
Electronic Module Technology MT-04	92,976	59,716	64,726	94,090	125,160	125,312	127,240	132,425	Continuing	Continuing
Tactical Information Systems MT-05	20,697	24,369	34,884	35,646	30,940	34,148	27,500	27,500	Continuing	Continuing
Microwave and Analog Front End Technology (MAFET) MT-06	41,665	41,234	28,019	13,183	1,000	0	0	0	0	N/A
Centers of Excellence MT-07	16,781	20,449	4,000	0	0	0	0	0	0	N/A
Manufacturing Technology Applications MT-08	59,336	32,201	32,355	25,200	21,951	0	0	0	0	N/A
Advanced Lithography MT-10	57,154	62,704	32,000	32,000	32,000	32,000	32,500	30,754	Continuing	Continuing
Electronic Commerce Resource Centers MT-11	31,073	34,301	0	0	0	0	0	0	0	N/A
Microelectromechanical Systems (MEMS) MT-12	30,435	62,238	72,060	71,549	69,281	60,000	50,000	50,000	Continuing	Continuing
Advanced Microsystems MT-13	0	0	0	0	30,000	35,000	35,000	35,000	Continuing	Continuing

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E

(U) **Mission Description:** The Advanced Electronics Technology program element is budgeted in the Advanced Technology Development Budget Activity because it seeks to design and demonstrate state-of-the-art manufacturing and process technologies for the production of various electronics and microelectronic devices, sensor systems, actuators, and gear drives that have both commercial and military applications. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements and enhance the U.S. industrial base.

(U) The IR Focal Plane Array project focuses on the establishment of a manufacturing capability for advanced infrared sensor arrays for major weapons systems. This industrial base will allow the systems to meet specification requirements at approximately 1% of the current cost.

(U) The Electronic Module Technology project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog, and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards and emerging technologies such as high density Multichip Modules (MCMs).

(U) The Tactical Information Systems project contains three major programs: Head Mounted Displays (HMD), Smart Modules, and Warfighter Visualization. The Head Mounted Display program is developing world-class miniature displays and integrating these displays into head and helmet mounted configurations for use by pilots, combat vehicle crews and individual warriors as well as for virtual environments and simulation. Smart Modules is a program to design and develop prototype modules, using core technologies that sense, think, and communicate, and integrate them into selected personal information products. Warfighter Visualization is a program to demonstrate the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters.

(U) The Microwave and Analog Front End Technology (MAFET) project is the only DoD effort directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities. It will provide urgently needed improvements in the performance and affordability of microwave and millimeter wave components. The MAFET program addresses the essential foundation for all DoD systems and programs making use of microwave and millimeter wave solid state technology.

(U) The Centers of Excellence project finances demonstration, deployment of and training on advanced manufacturing technologies. The goal of this technology is to reduce unit and life-cycle costs while improving quality.

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(U) The goal of the Manufacturing Technology Applications project is to reduce the cost and acquisition leadtime of future military systems by integrating manufacturing process considerations during the product design phase, and by demonstrating high efficiency multi-product prototype factories. This project will also enable manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies.

(U) Advanced Lithography technology has enabled the dramatic growth of integrated circuit capability. Advances have led directly to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability.

(U) The mission of the Electronic Commerce Resource Centers project is the transfer of electronic commerce technologies to small- and medium-size enterprises through a network of regional deployment centers. This program will transition to the Defense Logistics Agency as of FY 1998.

(U) The Microelectromechanical Systems (MEMS) project was previously included in MT-04, the Electronic Module Technology Project. This program is a broad and cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components, and integrated microelectronics to the design and construction of integrated electromechanical systems. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards, and physiological states.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
IR Focal Plane Array MT-03	39,493	23,076	9,000	11,000	3,000	0	0	0	0	N/A

(U) **Mission Description:** The Infrared Focal Plane Array project addresses the technology necessary to produce affordable, infrared (IR) sensor arrays, essential to major weapon systems. The focal plane array consists of a two dimensional detector array sensitive in a broad spectral range, integrated with unique signal processing to enhance performance and provide more efficient utilization of the information. The critical elements of the technology addressed in this program include the infrared material, detector array fabrication, read-out electronics, cryogenic packaging and testing, and module assembly. Processing and fabrication techniques focus on the production of affordable arrays, at low volume, in the configurations required by weapon systems. Performance enhancements in uncooled infrared and near-infrared sensors are also being addressed to provide an integrated, broadband two dimensional sensor array without the cryogenic package usually associated with infrared sensors. Elimination of the cryogenic package dramatically reduces the cost of the sensor module, and provides a sensor package compatible with a wide range of system applications, including navigation, targeting and manportable systems. The solid state integrated sensor also solves the problem of blooming in the presence of high intensity sources, which is encountered with current low light level visible and near infrared sensors. Arrays will be built in the configuration required for missile seekers; target acquisition and navigational platforms; search and track; and threat warning systems.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Completed development of standard electronic cells for rapid design and fabrication of infrared read-out circuits. ($9.0M)
- Demonstrated uncooled focal plane arrays hybridized to low noise analog readout circuits. ($5.0M)
- Demonstrated focal plane array fabrication using four inch diameter silicon wafers. ($14.0M)
- Verified computer aided design tool for infrared sensors; including cryogenic packaging. ($11.5M)

(U) FY 1997 Program:

- Complete single-wafer IRFPA processing on six inch silicon wafers. ($6.0M)
- Demonstrate capability to fabricate uncooled infrared sensor with one million pixels. ($5.5M)
- Assess capability to fabricate thin film ferroelectric uncooled infrared sensor. ($4.0M)
- Evaluate imaging performance and anti-blooming of uncooled solid state sensor. ($7.6M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-03

(U) FY 1998 Program:

- Demonstrate uncooled infrared array with thermal sensitivity of 0.05 degrees. ($4.0M)
- Demonstrate low light level solid state imager with anti-blooming protection. ($5.0M)

(U) FY 1999 Program:

- Fabricate and test integrated uncooled infrared array and solid state, low light level array with anti-blooming protection. ($7.0M)
- Establish feasibility of a solid state imager with spectral response beyond night vision goggles. ($4.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	36.7	24.0	9.0	14.0
Appropriated	35.8	23.1	N/A	N/A
Current Budget	39.5	23.1	9.0	11.0

(U) **Change Summary Explanation**:

FY 1996 Increase is due to increased uncooled technology efforts.
FY 1999 Decrease is due to rephasing of program.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 97	Demonstrate gain stage integrated into the pixel unit cell.
Sep 97	Evaluation of high performance uncooled sensor array.
Sep 98	Evaluation of large area uncooled sensor with less than 0.05 degree thermal sensitivity.
Jan 00	Evaluation of integrated sensor with broad band infrared response.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Module Technology MT-04	92,976	59,716	64,726	94,090	125,160	125,312	127,240	132,425	Continuing	Continuing

(U) **Mission Description:** The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog, and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards and emerging technologies such as high density Multichip Modules (MCMs).

(U) The project has four major objectives: (1) shorten the overall design, manufacture, test, and insertion cycle for advanced electronic subsystems; (2) advance the state-of-the-art in electronic interconnection and physical packaging technology to allow circuits to operate close to their intrinsic maximum speed with less overhead in terms of volume, weight and cost; (3) provide a robust manufacturing infrastructure for electronic modules; and (4) demonstrate the system level payoff of electronic module technology through advanced technology demonstrators (ATDs).

(U) The project has the following major elements: Application Specific Electronic Modules (ASEM); Multichip Integration (MCI); Rapid Prototyping of Application Specific Signal Processors (RASSP); Optical Micro-Networks (OMNET); Cooperative Adaptive Payloads (CAPS); Infrared Artificial Dielectrics (IRADs); and Design Support for mixed Technology Integration (Composite CAD). ASEM will reduce the non-recurring engineering time and cost for designing and inserting complex electronic modules. MCI will produce order of magnitude reductions in manufacturing cost and accelerate the acceptance and insertion of Multichip Integration technologies. RASSP is a major DARPA/tri-Service initiative which seeks to dramatically reduce the development time and life cycle cost of advanced signal processing capability. OMNET seeks to demonstrate new paradigms for integrating electronic, electromechanical, and electro-optical components to enable small, lightweight, battlefield information systems. Distributed Robotics is a new effort to integrate developments in MEMS, power sources, communications, and advanced microelectronics to design, construct and field multiple, high-performance, mobile, autonomous systems. Composite CAD seeks to enable the design of systems incorporating emerging micro-devices and manufacturing processes by developing the design technology (tools, methodology, and architectures) to support device and systems design of mixed-technology integrated systems.

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(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Completed development of required microwave packaging approaches and interconnection circuitry; produced and demonstrated required multichip microwave assemblies. ($10.0M)
- Demonstrated complete end-to-end Rapid Prototyping of Application Specific Signal Processors (RASSP) design framework with additional demonstration hardware and benchmark evaluations. Developed accelerated framework standards, improved Computer Aided Design (CAD) technology for system testing, and reuse libraries. Accelerated technology transfer activities. ($32.2M)
- Continued Application Specific Electronic Modules (ASEM) program to reach one month turn-around time and $25K non-recurring engineering (NRE) cost for digital Multichip Modules (MCMs). Demonstrated high volume production technology for producing known-good die. ($19.6M)
- Continued Multichip Integration (MCI) program with the delivery of high volume/low cost laminate MCM technology and developed optimized modules and mixed signal applications. ($20.1M)
- Expanded the current effort in Seamless High Off-Chip Connectivity (SHOCC) to include a full scale demonstration of a high-performance microprocessor. This demonstration segmented the integrated circuit design into yield and performance-optimized active elements, fabricated these elements and assembled a fully-functional device on a passive substrate incorporating traces formerly within the chip. Mating of the active die to the substrate was through a high-density interposer. ($9.6M)
- Reprioritized design activities to focus on enabling highly integrated mixed-technology electronic systems which include digital, analog, MEMS and optics devices. ($1.5M)

(U) FY 1997 Program:

- Complete and demonstrate final end-to-end RASSP signal processor design environment. Complete technology insertion demonstrations, benchmarking analysis, and technology transition activities. ($7.2M)
- Continue ASEM technology development and demonstrate new ASEM foundry capability for flexible production of modules with board-level integration. ($11.8M)
- Continue Multichip Integration program to demonstrate order of magnitude reductions in MCM manufacturing costs and MCM technology insertions. Continue insertion of MCM technology into dual-use products such as workstations, engine control and wireless communications. ($22.6M)
- Initiate OMNET program to demonstrate new paradigms for integrating electronic, electromechanical, and electro-optical components to enable small, lightweight, battlefield information systems. ($9.1M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-04

- Continue to refocus ASEM and MCM design technology to support the design of composite electronic systems from composable design tools (electronics composite CAD). Focus on multi-technology lumped behavior modeling capability. ($4.3M)
- Leverage ongoing design efforts to enable design of highly integrated MEMS devices coupled with electronics through the development of coupled energy modeling of 3D devices (MEMS and optics composite CAD). ($4.7M)

(U) FY 1998 Program:

- Complete ASEM program to reduce non-recurring engineering cost for designing and inserting multi-chip modules. ($4.0M)
- Complete the Multichip Integration (MCI) program to improve substrate fabrication, demonstrate reductions in Multichip Modules (MCM) manufacturing costs, and technology insertions. ($14.3M)
- Optical Micro-Networks (OMNET) - Downselect amongst heterogenous integration technologies and demonstrate multi-functional integration of electronic, electro-mechanical and optoelectric components targeted to military information systems. ($12.7M)
- Distributed Robotics - Initiate effort to put together in one package low-weight (<2 kg), high-performance payloads including sensors, imagers, countermeasures, designators, communications, and munitions. ($8.0M)
- Composite CAD - Integrate a composable design capability for single chip electronics and MEMS systems. Develop models with parameters optimized for manufacturing variances. Initiate behavior modeling of mixed technology devices. ($17.0M)
- Molecular-level, Large-area Printing (MLP) - Establish preliminary micro-molding process using commercially available (CD manufacturing) tool; initiate studies of alternative micro-printing processes (letterpress, gravure, tropomorphic). ($8.7M)

(U) FY 1999 Program:

- OMNET - Demonstrate integrated optoelectronic transceivers and optical switches for reconfigurable interconnections of sensors to processors and the ability to distribute computation across military platforms 1-100 meters in length for future Electronic Warfare/digital radar and image processors. ($18.0M)
- Distributed Robotics - Construct the unit platforms, integrate commercial or demonstrated technology elements (e.g., imagers, MEMS, wireless systems), and field packs/herds of units to demonstrate multiple, cooperative functions. ($19.0M)
- Composite CAD - Continue to develop the mixed domain (kinematic, electric, electrostatic, and fluidic) analysis of micro-machined devices, systems of devices and corresponding electronic circuits to support the design of composite electronic sensors and systems. ($18.0M)

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- Explore new effort on developing technology for ultra-small, low cost multi-cast digital radio. ($11.0M)
- Develop small personal inertial and GPS based navigation chip for small unit operations. ($10.0M)
- MLP - Complete experimental characterization of release agents for micromolding; select candidate printing processes (≤2) and compatible readout process for development; and demonstrate writing on non-flat surfaces with radii of curvature in the range 1m to 1cm. ($18.1M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	134.5	66.2	93.2	144.8
Appropriated	136.7	63.5	N/A	N/A
Current Budget	93.0	59.7	64.7	94.1

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects: creation of a separate MT-12 MEMS Project for greater program visibility; Bosnia supplemental rescissions; and internal reprioritization of programs.

FY 1997-99 Decreases reflect realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 97	Demonstrate final end-to-end Rapid Prototyping of Application Specific Signal Processors (RASSP) signal processor design.
Sep 97	Demonstrate new mixed signal ASEM foundry capability.
Jun 98	Demonstrate efficient 3-D electromagnetic modeling capability.
Aug 98	Complete testing of integrated optoelectronic devices.
Sep 98	Demonstrate MCM substrates with integrated passive components.
Jul 99	Demonstrate mixed energy domain analysis capability for integrated technology devices.
Aug 99	Demonstrate optical micronetwork with reconfiguration capability.
Nov 99	Initial prototype of tightly integrated adaptive payload technology.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Tactical Information Systems MT-05	20,697	24,369	34,884	35,646	30,940	34,148	27,500	27,500	Continuing	Continuing

(U) **Mission Description:** This project is a major DoD effort to develop the technology for displays and portable information systems for use in a variety of military systems. The project has three major efforts: Head Mounted Displays (HMDs), Smart Modules, and Warfighter Visualization. The Head Mounted Displays develops world-class miniature displays and integrates these displays into head and helmet mounted configurations for use by pilots, combat vehicle crews and individual warriors as well as for virtual environments and simulation. Smart Modules designs and develops prototype modules, using core technologies that sense, think, and communicate, and integrate them into selected personal information products. Warfighter Visualization demonstrates the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Completed all on-going miniature display efforts and initiated feasibility demonstrations for miniature diffraction grating displays and Microelectromechanical Systems (MEMS) based displays. ($10.1M)
- Demonstrated four systems for use by individuals remotely located from conventional information sources. Initiated developments to demonstrate individually worn direction finding and video capture capability. ($10.6M)

(U) FY 1997 Program:

- Demonstrate feasibility of diffraction grating and MEMS based miniature displays. Diffraction grating displays will integrate drivers, standard interfaces, memory and controller circuitry directly on the display. This will improve the range of applications for which the display can be applied and significantly reduce power consumption requirements. The MEMS display will use a novel micro-beam steering device to control the movement of a fiber optic to scan a mirror with an image. This type of display will greatly reduce the head-borne weight to a few ounces and significantly reduce power consumption over currently available displays. (5.7M)

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- Demonstrate the feasibility of combining computation, wireless communicating capability, and high resolution display in a paper sized device operating on commercially available batteries. Device will be built using shape deposition manufacturing processes to demonstrate rapid, cost-effective prototyping. The device will be used to receive text, graphics and video and provide limited transmitting capability. Demonstrate electronic information capability integrated into soldier's clothing. A soldier's vest will incorporate computers, GPS, radio, batteries and PC card slots for various peripherals. First demonstration will be for Army maintenance application. ($14.8M)
- Develop several technology efforts that will allow tracking of hand and head motion for mobile, untethered individuals. ($3.9M)

(U) FY 1998 Program:

- Demonstrate prototype electric countermeasures system integrated into a solider worn vest. The computational capability developed in the FY 1997 program will be augmented with two PC cards containing ECM circuitry and will allow dismounted soldiers to instantly locate radio emissions from hostile forces. Demonstrate a prototype water proof computer for underwater use in SEAL and Explosive Ordnance Disposal applications. ($15.3M)
- Demonstrate prototype inertial navigation device integrated into soldier boots. This device will use miniature accelerometers and gyros to measure direction and distance traveled. It will be used to augment GPS navigation when the user is in areas where satellite reception is unavailable. ($6.0M)
- Continue efforts to develop hand and head motion tracking technologies. Tracking head movement will allow a computer to display information to a head mounted display that is registered in the geospatial direction that the individual is looking. Tracking hand motion will allow a computer to recognize pointing and gestures as input mechanisms instead of using a keyboard. ($6.3M)
- Demonstrate image capture and geospatial registration of icons on terrain in a moving vehicle. The vehicle will be equipped with video cameras that provide a 360 degree view. Inside the vehicle, a person wearing a head tracked, head mounted display will be able to look around and view the images obtained from the cameras. Icons and graphical images generated by a computer will be overlayed on the camera image in the head mounted display. These images will be registered with the viewed real-world terrain. ($7.3M)

(U) FY 1999 Program:

- Demonstrate a novel capture device that incorporates signal and data processing in a 3-D package for use by individual soldiers. This miniature device weighing only a few ounces will be able to capture an image and rapidly analyze movement or correlate images with all processing done on the focal plane. The camera will

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be able to be worn by individual soldiers and communicate via a radio to and from geographic information system data bases. ($9.2M)

- Demonstrate a wearable computer incorporating wireless communication in a one pound, one watt configuration. This represents a 3x improvement in weight and a 10x improvement in power over current technology. The wearable computer will be used in a wide variety of applications by the small unit operations soldier. ($9.0M)
- Demonstrate prototype capability for dismounted soldiers to view the real world with overlayed graphic symbology. This capability will allow the soldier to receive visual information that is relevant to his/her mission time or location. It will also allow the soldier to interrogate databases containing information about the specific objects in his/her viewing environment. ($5.8M)
- Demonstrate prototype "see-through" tank concept. This capability will allow a "buttoned-up" tank crew wearing head mounted displays to view the outside world as though the tank were made of glass. This will be accomplished by placing cameras on the outside of the tank that provide inputs to a mapped memory. Images will be fed to the users head mounted display depending upon the direction that the user is looking. This capability will significantly enhance the situation awareness of the tank crew. ($6.5M)
- Demonstrate a capability to obtain one-dimensional and two-dimensional data from a submarine sensor suite and configure these data into a 3-dimensional image covering 360 degrees that is provided to a head tracked, head mounted display. This capability will be used by a submarine conning officer to demonstrate an enhanced capability for under ice submarine navigation. ($5.1M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	20.2	19.1	22.8	21.6
Appropriated Budget	19.6	18.4	N/A	N/A
Current Budget	20.7	24.4	34.9	35.6

(U) **Change Summary Explanation**:

FY 1996 Increase reflects minor repricing.
FY 1997-99 Increase reflects reprioritization of internal programs for additional efforts in the head and hand motion tracking arena.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jan 97	Integrated CCD, memory, wireless interface in Technology Advanced Mini Eyesafe Rangefinder (TAMER).
Jan 97	Integrated wireless interface and display in TAMER.
Feb 97	2560 x 2048 pixel display demonstration for head mounted displays.
Mar 97	Demonstrate electronic information system incorporated in soldier clothing.
Sep 97	Diffraction grating display demonstration for head mounted displays.
Nov 97	Demonstrate electronic countermeasures system in soldier vest.
Dec 97	Demonstrate waterproof/computer for soldier clothing.
Feb 98	Prototype head and hand tracking demonstration.
Feb 98	Demonstrate low power display for future head mounted displays.
Mar 98	Demonstrate air combat, air controller modules.
Apr 98	Demonstrate prototype see-through vehicle concept.
Dec 98	Demonstrate image capture sensor using 3-D packaging.
Feb 99	Demonstrate 1 pound, 1 watt wearable computer system.
Feb 99	Real world viewing with computer generated graphic overlay demonstration.
Jul 99	Demonstrate see-through tank.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microwave and Analog Front End Technology MT-06	41,665	41,234	28,019	13,183	1,000	0	0	0	0	N/A

(U) **Mission Description:** Microwave and millimeter wave technology for DoD electronic weapon systems is at a critical crossroads. Great progress has been made under the microwave and millimeter wave integrated circuit (MIMIC) program in terms of maturing the gallium arsenide industrial community. The DoD is now far ahead of the commercial world in microwave and millimeter wave technology in terms of performance characteristics. However, in many cases, radio frequency (RF) sub-system costs are still a major impediment to fielding DoD weapon systems. Material, processes and design technology advances must be undertaken to sustain an effective defense capability and to maintain U.S. dominance in this critical technology area. The Microwave and Analog Front End Technology (MAFET) program is the only DoD effort directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities and advanced technologies. It will provide urgently needed improvements in the performance and affordability of microwave and millimeter wave components. The MAFET program addresses the essential foundation for all DoD systems and programs making use of microwave and millimeter wave solid state technology.

(U) Specifically, the MAFET program will provide the DoD with the state-of-the-art electronic systems that it needs to maintain its force multiplying capability. The program will: (1) reduce design time and cost for every RF system being developed or upgraded through an improved microwave/millimeter wave design environment; (2) break the very expensive cycle and time-consuming current practice of design-build-test--redesign-rebuild-retest; (3) put in place repeatable, robust processes to produce high frequency components; (4) make strategic investments in critical passive, packaging and integrated circuits devices needed for millimeter wave systems; and (5) investigate revolutionary solutions to the long-standing problem of insufficient power in solid-state radar and communications transmitters.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Continued development and implementation of microwave/millimeter wave computer aided design (CAD) environment with quantitative demonstration of ability to reduce time and cost of producing microwave and

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millimeter wave products. Continued development and implementation of Microwave Hardware Description Language (MHDL). ($10.0M)

- Continued development of advanced sensor technology with demonstrations of improved performance coupled with cost savings. Demonstrated state-of-the-art millimeter wave probes. ($25.4M)
- Selected most appropriate system application areas and began demonstration tasks that will allow quantitative assessment of subsystem and system performance improvements and cost savings resulting from Microwave and Analog Front End Technology (MAFET) activities. Began benchmark development and assessment of design tool advances. ($3.1M)
- Investigated novel concepts, methodologies, and passive components for high-power, ultra-low-cost, all-solid-state microwave sources and high millimeter wave sources. ($3.2M)

(U) FY 1997 Program:

- Continue microwave/millimeter wave computer aided design environment development with implementation of advanced microwave/millimeter wave CAD tools and integrated tool sets and implementation of improved models. Conduct assessment and demonstration of design environment effectiveness through quantitative assessment of benchmarking metrics. Continue development and implementation of MHDL. ($11.2M)
- Complete advanced sensor technology developments in the area of millimeter wave test. In addition, demonstrate: (1) millimeter wave InP high electron mobility transistor (HEMT) monolithic microwave integrated circuits (MMICs) with high yield; (2) low cost, high Indium-content field effect transistor (FET) materials on gallium arsenide; (3) microwave and millimeter wave device arrays; (4) advanced mixed signal chips for highly integrated frequency synthesizers; (5) low cost MMIC components for electronic warfare transmitter arrays; (6) miniaturized microwave and millimeter wave ferrite circulators; (7) automated millimeter wave load pull test station; and (8) on-wafer known good die test station. Continue development of remaining advanced sensor technology with demonstrations of improved performance coupled with cost savings. ($19.4M)
- Begin development of all-solid-state X-band source with high output power and low fabrication cost. ($4.0M)
- Begin development of all-solid-state quasioptical Ka-band source with high output power. ($3.0M)
- Demonstrate MEMS X-band phase shifter technology at high power and ultra low loss. ($1.0M)
- Begin development of MEMS controlled beam-steering module at mm-wave frequencies. ($.8M)
- Begin development of high-power (10W) W-band solid-state MMICs. ($1.8M)

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(U) FY 1998 Program:

- Complete microwave/millimeter wave computer aided design environment. Demonstrate design environment effectiveness. Continue implementation of Microwave Hardware Description Language (MHDL). ($9.5M)
- Complete advanced sensor technology developments in the areas of: advanced fabrication, packaging, and multichip assembly (MCA) foundries. In the fabrication area, demonstrate: (1) production InP HEMT and HBT millimeter wave processes; (2) advanced manufacturing processes for: High power and high efficiency, and high dynamic range, capability; and (3) highly manufacturable and reliable HBT high power amplifiers. In the packaging area, demonstrate: (1) a 10x cost reduction in plastic HDI module fabrication technology; and (2) a 7x RF interconnect/package reduction due to embedded transmission lines and advanced multilayer interconnect. In the foundry area, demonstrate a 5x reduction in MCA production cost. ($7.9M)
- (1) In novel high-power transistor area, demonstrate 5-W SiGe HBT solid-state power amplifier (SSPA) having near-50% power-added efficiency (PAE) at X-band; Demonstrate 10-W GaN MODFET having PAE=50% in X band; Demonstrate 25-W SiC MESFET having PAE=45% in X band. (2) In quasioptics area, continue development of solid-state quasioptical Ka-band sources with high output power and high coherence; Complete and demonstrate numerical design tool. (3) In MEMS-switch area, demonstrate 4-bit true-time-delay phase shifter in (a) X-Band with 2-dB total loss, and (b) Ka-Band with 3-dB loss; Demonstrate 20/44-GHz dual-frequency MEMS-switched planar antenna. (4) In micromachined circuits and novel thermal management area, demonstrate micromachined W-band Wilkinson combiners in Si substrates; Demonstrate Flourinert cooling of a 10-W X-band MMIC and a 1-W Ka-band MMIC. ($10.6M)

(U) FY 1999 Program:

- In quasioptics area, demonstrate a set of quasioptical grid-, array-, card-, and slab-combined power amplifiers including (a) a 100-W 50%-PAE card amplifier at 10 GHz, (b) a 20-W-output >25%-PAE array amplifier at 35 GHz, (c) a 20-W-output 15-to-20%-PAE grid amplifier at 40 GHz, (d) a 10x10-element 10-W electronically-steerable array amplifier at 44 GHz, and (e) a 5-W 20%-PAE slab-amplifier at 94 GHz. ($5.6M)
- In novel high-power-transistor area, demonstrate 100-W-output GaN and SiC SSPAs operating across X band. ($2.9M)
- In MEMS-switch area, demonstrate MEMS-tunable Chebyshev filter operating at 20 and 45 GHz; Demonstrate MEMS-array transmitting beam-steerer at 44 GHz. ($2.9M)
- In micromachined circuits and novel thermal management area, demonstrate a micromachined SSPA ("W-Band Power Cube") having 2 W/in^2 intensity radiated from top facet. The power cube will be fabricated with InP Power MMICs that are thermally managed by bump bonding and are coupled to free space by Si-micromachined feed-line and planar-antenna structures. ($1.8M)

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(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	50.7	47.9	50.9	28.2
Appropriated	42.6	45.9	N/A	N/A
Current Budget	41.7	41.2	28.0	13.2

(U) **Change Summary Explanation**:

FY 1996 Decrease due to Bosnia reprogramming action.
FY 1997 Adjustment reflects program rephasing.
FY 1998-99 Decrease reflects program phase down.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 97	Standard for simulator and design environment interoperability.
Mar 97	Produce broadband electronic warfare multichip assemblies.
Jun 97	Demonstrate millimeter wave test probes and automated on-wafer test station.
Sep 97	Demonstrate high power MEMS phase shifters.
Mar 98	Demonstrate 20-W X-band all-solid-state sources.
Jun 98	Demonstrate embedded transmission line MMICs.
Sep 98	Ultra-low-cost SiGe T/R modules.
Dec 98	Demonstrate 10-W millimeter wave power amplifier array.
Jan 99	Demonstrate millimeter wave micromachined solid-state power amplifier.
Mar 99	Demonstrate millimeter wave beam steering module.
Jun 99	Demonstrate > 100-W low cost X-band electronically steerable source.
Sep 99	Demonstrate full interoperability of CAD vendors.

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RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Centers of Excellence MT-07	16,781	20,449	4,000	0	0	0	0	0	0	N/A

(U) **Mission Description:** This project provides funding for Centers of Excellence including the Robert C. Byrd Institute for Advanced Manufacturing at Marshall University, and the Focus: HOPE National Center for Advanced Technologies (NCAT). The purpose of these Centers is to demonstrate, deploy and provide advanced manufacturing technology to significantly reduce unit production and life cycle costs, improve product quality, and deploy manufacturing training systems.

(U) The Institute for Advanced Flexible Manufacturing provides both a teaching factory and initiatives to local area industries to utilize computer-integrated manufacturing technologies and managerial techniques to improve productivity and competitiveness. The National Center for Advanced Technology (NCAT) is a component of the Focus: HOPE Project whose purpose is to train technicians/engineers in advanced manufacturing processes and methods, demonstrate state-of-the-art flexible manufacturing and serve as a testbed for emerging manufacturing research.

(U) This project also includes funding in FY 1997 for the U.S.-Japan Management Training Program whose purpose is to build a growing infrastructure of American scientists and engineers with knowledge about the Japanese R&D enterprise and provide training in the Japanese language.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Focus: HOPE. ($12.9M)
  - Developed software to integrate 3D computer models with numerically controlled machine tools, and demonstrated its production capability.
  - Demonstrated an electronic (digital) library in the context of education and training of machinists.
- Institute for Advanced Flexible Manufacturing. ($3.9M)
  - Developed, demonstrated and evaluated new technologies for insertion and transfer to manufacturing centers and industry with a focus on small- to medium-sized manufacturing companies.

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(U) FY 1997 Program:

- Focus: HOPE. ($9.5M)
  - Continue development and demonstration of software to integrate computer models with numerically controlled machine tools.
  - Continue efforts to demonstrate a digital library to enhance the education and training of machinists.
- Institute for Advanced Flexible Manufacturing. ($4.0M)
  - Continue the on-going technology development that includes technology evaluation, research into dual-use flexible manufacturing and technology transfer to local business at the Institute for Advanced Flexible Manufacturing. Establish satellite sites to ensure broader technology deployment.
- U.S.-Japan Management Training. ($7.0M)
  - Continue efforts with centers of excellence to facilitate students', researchers', and executives' understanding of Japan's manufacturing infrastructure, culture and language.

(U) FY 1998 Program:

- Institute for Advanced Flexible Manufacturing. ($4.0M)
  - Complete development of internetting capabilities to ensure medium- and small-sized businesses have access to emerging electronic commerce and advanced technologies.

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	17.1	14.0	0	0
Appropriated	18.8	20.5	N/A	N/A
Current Budget	16.8	20.5	4.0	0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming action.
FY 1998 Increase reflects additional funding to support Institute for Advanced Flexible Manufacturing.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jun 97	Demonstrate capability to utilize computer models for the control of numerical control machine tools.
Oct 97	Demonstrate the use of digital library for enhancing the education and training of machinists.
Oct 98	Demonstrate advanced internetting capabilities that can be utilized by medium- and small-sized businesses to access emerging electronic commerce and advanced technologies.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Manufacturing Technology Applications MT-08	59,336	32,201	32,355	25,200	21,951	0	0	0	0	N/A

(U) **Mission Description:** Future military systems will be affordable only if the manufacturing process is considered as an integral part of product design, production takes place in flexible, multi-product factories, and if advanced manufacturing technology is combined effectively with advanced business practices. This program focuses on demonstrations of process technology combined with innovative industrial practices, and will measure the improvements in cost, schedule and quality achievable in key defense product areas. Three major initiatives are included in the FY 1996-2000 program: Affordable Multi-Missile Manufacturing (AM3); Agile Manufacturing Pilot Programs; and the DARPA/Tri-Service Flexible Interferometric Fiber Optic Gyroscope (IFOG) Manufacturability Program.

(U) The Affordable Multi-Missile Manufacturing (AM3) program is an Advanced Technology Demonstration initiated in FY 1995. The objective of AM3 is to demonstrate the feasibility of 25-50% reductions in the unit cost of tactical missiles, both in ongoing missile production programs and in new missiles and major modifications. This will be accomplished by teams of missile prime contractors, component suppliers and manufacturing equipment and software vendors who develop and demonstrate the combined effects of advanced design, manufacturing, assembly systems and processes, missile value engineering changes, and acquisition reform and business practice innovations. A major technical theme is to achieve economies across a mix of missiles to compensate for the decline in individual missile quantities. Demonstrations will be conducted in the design and manufacture of components and guidance and control/seeker assemblies for multiple missiles, including R&D and production programs.

(U) Agile Manufacturing is an industry-developed vision for 21st century manufacturing, which focuses on the ability to thrive in an environment of changing product technologies, customer demands, and development and production team members. This new paradigm is ideally suited to the needs of defense manufacturing in the future. Agile Manufacturing Pilot Programs are structured to evaluate the manufacturing enterprise concepts and enabling technology required for agility on and above the factory floor. Since over 50% of the cost of weapon systems is attributable to components from lower tier suppliers, the major emphasis is on tightly integrating the supplier chain and other elements of the manufacturing enterprise.

(U) Interferometric Fiber Optic Gyroscopes (IFOG) are emerging as preferred technology for future military and commercial inertial navigation applications. The emphasis of the IFOG Manufacturability Program is on achieving the

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design and manufacturing flexibility required to make low volume Defense components economically viable when compared to high volume commercial production. This program will develop the large throughput robotic assembly, packaging and testing technologies necessary to fabricate navigation-grade (0.01 deg/hr) Interferometric Fiber Optic Gyroscopes (IFOGs) at less than $1,500 per axis as a goal. This will enable affordable, accurate (1nm/hr) inertial navigators for use during extended periods of Global Positioning System (GPS) signal outage due to enemy jamming or signal obscuration. Flexible manufacturability enables, from the same production line, fabrication of navigation grade, military tactical grade (0.1 - 1.0 deg/hr) IFOGs and lower performing (> 1 deg/hr) commercial IFOGs. Example technology development areas include: (1) low loss, low reflectivity, polarization-preserving optical connections between optical fiber subassemblies, optical sources, detectors and miniature integrated optical circuits; (2) rapid, precision coil winding machines; (3) geometrically stable, environmentally robust (temperature and vibration) packaging of critical optical subassemblies; and (4) automatic testing machines. Phase 1 identified IFOG manufacturing process requirements for components, subassemblies and complete IFOG units. Phase 2 will demonstrate advanced manufacturing methods, controls and equipment.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Affordable Multi-Missile Manufacturing (AM3). ($23.7M)
  - Completed Affordable Multi-Missile Manufacturing (AM3) Phase 1, approved validation plans, and initiated Phase 2 demonstrations to assess and mitigate risks, including simulation and modeling, design and component-level manufacturing demonstrations, and qualification testing.
  - Competitively selected two system vendors for the development of supply chain integration technologies to fill gaps identified in AM3 Phase 1.
  - Continued AM3 technical integration activities, conducted independent evaluation of contractor cost savings analyses and completed initial set of benchmark comparison studies for the missile sector.
- Agile Manufacturing Program. ($16.2M)
  - Completed Agile Manufacturing business practice demonstrations and documentation, inserted results in Pilot Program testbeds, and disseminated results for DoD and industry implementation.
  - Completed Agile Manufacturing enabling technology demonstrations, initiated beta test in Pilot Programs, and transferred technology through the Industry Forum and through vendor products.
  - Completed Agile Manufacturing pilot programs in space launch vehicles and castings.
  - Continued Agile Manufacturing industry forum activities, including delivery of agility tool kit and knowledge base, and transition to self-sustainment.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-08

- Interferometric Fiber Optic Gyroscope (IFOG). ($19.4M)
  - Developed and implemented manufacturing processes for coil winding and optical components/subassemblies.
  - Completed IFOG architectures and began to develop and implement manufacturing processes.

(U) FY 1997 Program:
- Affordable Multi-Missile Manufacturing (AM3). ($11.8M)
  - Complete AM3 Phase 2 component-level validation demonstrations.
  - Competitively select at least two pilot enterprises for AM3 Phase 3, and initiate cost-shared implementation and demonstration of concepts and technology across the target missile mix.
  - Initiate first demonstrations of supply chain technologies to fill gaps identified in AM3 Phase 1 and continue technical integration and independent cost analysis.
- IFOG. ($20.4M)
  - Evaluate wound coils and packaged subassemblies for IFOG.
  - Continue to implement brassboard Interferometric Fiber Optic Gyroscopes (IFOG) unit manufacturing processes.
  - Deliver superluminescent optical sources.

(U) FY 1998 Program:
- Affordable Multi-Missile Manufacturing. ($26.2M)
  - Continue AM3 Phase 3 implementation of new factory systems and new business practices in at least two pilot enterprises.
  - Complete initial design and test planning for AM3 multi-missile components and value engineering change proposals.
  - Complete initial demonstrations of supply chain technologies to fill gaps identified in AM3 Phase 1, and continue technical integration and independent cost analysis.
- IFOG. ($6.2M)
  - Demonstrate flexible production of navigation grade and tactical grade IFOG units.
  - Demonstrate production of high power, stable, packaged optical sources, low cost couplers and wavelength division multiplexers.

(U) FY 1999 Program:
- Affordable Multi-Missile Manufacturing. ($25.2M)

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- Continue AM3 Phase 3 implementation of flexible multi-product assembly cells and prototype production of missile hardware.
- Conduct initial tests of missile seekers built with the Affordable Multi-Missile Manufacturing (AM3) scalable family of parts and commercial components.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	66.1	34.1	33.5	25.0
Appropriated	67.3	32.5	N/A	N/A
Current Budget	59.3	32.2	32.4	25.2

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia supplemental rescissions and transfer of funds to the Small Business Innovative Research (SBIR) program element.

FY 1997-99 Changes reflect program repricing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jul 97	Complete AM3 Phase 2 demos, select at least two contractors for Phase 3.
Jul 97	Demonstrate production of novel wavelength stabilized Interferometric Fiber Optic Gyroscope (IFOG) light source.
Aug 97	Demonstrate winding of test coils with advanced coil winding machinery.
Oct 97	Complete IFOG advanced coil winding machinery.
Feb 98	Demonstrate assembly of brassboard IFOG units.
Dec 99	Complete AM3 Phase 3 multi-missile manufacturing demonstrations.
Jun 00	Complete flight tests of AM3 missile seeker prototypes.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Lithography MT-10	57,154	62,704	32,000	32,000	32,000	32,000	32,500	30,754	Continuing	Continuing

(U) **Mission Description:** Lithography technology has enabled the dramatic growth in microelectronics capability over the past three decades and microelectronics is a key to improved weapon system performance. The improved capabilities in semiconductor technology contribute to significant system gains in speed, reliability, cost, power consumption, and weight. Advanced microelectronics technology is essential for computing and signal processing throughout essentially all military systems, including command, control, communications, and intelligence, electronic warfare, and beam forming for radar and sonar. Further improvements in areas such as target recognition, autonomous guided missiles, and digital battlefield applications require microcircuits with smaller features to meet the operational speed, power, weight and volume constraints of these systems.

(U) Current microelectronics fabrication utilizes feature sizes of 0.35 microns. The Advanced Lithography Program emphasizes longer term research with expected high payoff in the fabrication of semiconductor devices with 0.1 or less micron feature sizes. These programs will develop technology for sub 0.1 micron features. Current programs in cross-cutting technologies (mask, stages, resists, metrology) and x-ray lithography will be completed in one - two years. Key subsystems of the maskless e-beam developments will be demonstrated late in the decade.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Demonstrated prototype projection electron-beam and ion-beam lithography lenses. ($10.0M)
- Demonstrated processing using x-ray lithography and point source development. ($23.0M)
- Developed alignment sub-assemblies and mask technology for 0.18 micron lithography system. ($13.0M)
- Developed key subsystems for a point source x-ray lithography system. ($11.2M)

(U) FY 1997 Program:

- Demonstrate full-chip stitching for e-beam projection (SCALPEL) and initiate maskless lithography efforts. ($10.0M)
- Install process for using tantalum absorber on SiC membrane for x-ray mask and demonstrate solid-state power supply for dense plasma focus source. ($42.0M)
- Demonstrate 25 wafers per hour throughput for synchrotron stepper and demonstrate gas-field ion source test column for mask repair. ($10.7M)

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(U) FY 1998 Program:

- Research efforts for sub 0.1 micron in maskless lithography (emitter arrays and photocathodes), innovative imaging materials, and network of university efforts in novel patterning. ($20.0M)
- Complete development on cross-cutting technology in precision stages and mask making (e-beam writing and inspection) for 0.13 - 0.10 micron features. ($12.0M)

(U) FY 1999 Program:

- Continue efforts in maskless lithography, including arrays of miniature e-beam columns, and novel imaging materials and pattern transfer processes.
  - Construct MEMS shutters for x-ray zone plate array. ($15.0M)
  - Complete column test stand for maskless e-beam writer. ($17.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	39.0	51.4	40.0	40.0
Appropriated	59.0	62.7	N/A	N/A
Current Budget	57.2	62.7	32.0	32.0

(U) **Change Summary Explanation:**

FY 1996 Decrease is due to Bosnia supplemental rescissions ($1.9 million) and minor program repricings ($+.1 million).

FY 1998-99 Decreases reflect realignment of program priorities.

(U) **Other Program Funding Summary Cost:** N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-10

(U) **Schedule Profile**:

Plan	Milestones
Sep 97	Demonstrate breadboard (alpha) version of electron-beam lithography system.
Jun 98	Demonstrate maskless printup of contact level using laser interferometric lithography.
Jun 99	Demonstrate switched emitter arrays for maskless lithography.
Mar 01	System demonstration of maskless charged particle writer.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Advanced Electronics Technologies,
PE 0603739E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electronic Commerce Resource Centers MT-11	31,073	34,301	0	0	0	0	0	0	0	N/A

(U) **Mission Description**: The mission of this program is the transfer of electronic commerce (EC) technologies to small- and medium-size enterprises (SMEs) through a network of regional deployment centers. This mission is a subset of the overall DoD plans for Continuous Acquisition and Life-cycle Support (CALS) and for electronic commerce as part of Acquisition Reform. To reflect the focus on that subset, the program name was changed in FY 1994 from CALS Shared Resource Centers to Electronic Commerce Resource Centers (ECRCs). The regional ECRCs provide training and technical assistance to aid SMEs in defense supply chains in making effective use of electronic commerce and CALS technologies. An ECRC technology hub has been established to keep abreast of EC technologies and to ensure that technical consultants in the regional ECRCs are equipped with the latest information and training on EC technologies. This program will be transitioned to the Defense Logistics Agency at the end of FY 1997.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:

- Electronic Commerce Resource Centers (ECRC). ($31.1M)
  - Follow-on contracts awarded to current ECRC integrators to continue ECRC network of sites for nationwide delivery of education, training, and technical support services (Congressional direction).
  - Continued Technology Hub operations with initiatives for Electronic Commerce (EC) Testbed, and for advances in tools needed for development of Standard for the Exchange of Product (STEP) data model applications.

(U) FY 1997 Program:

- Electronic Commerce Resource Centers (ECRC). ($34.3M)
  - Open five new ECRCs.
  - Complete DARPA funded ECRC technology development and deployment.
  - Transition program to the Defense Logistics Agency (DLA) for continued operation.

(U) FY 1998 Program: N/A

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-11

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	32.3	20.7	15.0	0
Appropriated	33.3	34.3	N/A	N/A
Current Budget	31.1	34.3	0	0

(U) **Change Summary Explanation**:

FY 1996 Decrease is due to Bosnia supplemental.
FY 1998 Program transfers to Defense Logistics Agency.

(U) **Other Program Funding Summary Cost**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
0603753S	0	0	15.0	0

(U) **Schedule Profile**:

Plan	Milestones
Sep 97	Complete transition of Electronic Commerce Resource Centers (ECRC) activities to Defense Logistics Agency.
Sep 97	Five new ECRCs open.

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COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Microelectromechanical Systems (MEMS) MT-12	30,435	62,238	72,060	71,549	69,281	60,000	50,000	50,000	Continuing	Continuing

(U) **Mission Description**: The Microelectromechanical Systems (MEMS) program is a broad, cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components, and integrated microelectronics to the design and construction of integrated electromechanical systems. The MEMS program addresses issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards, and physiological states.

(U) The MEMS program has three principal objectives: The realization of advanced devices and systems concepts; the development and insertion of MEMS products into DoD systems; and the creation of support and access technologies to catalyze a MEMS technology infrastructure. These three objectives cut across a number of focus application areas to create revolutionary military capabilities, make high-end functionality affordable to low-end systems, and extend the operational performance and lifetimes of existing weapons platforms. The major technical focus areas for the MEMS program are: 1) inertial measurement; 2) fluid sensing and control; 3) electromagnetic and optical beam steering; 4) mass data storage; 5) chemical reactions on chip; 6) electromechanical signal processing; 7) active structural control; 8) analytical instruments; and 9) distributed networks of sensors and actuators.

(U) Accomplishments to date include: A wind-tunnel test of an integrated MEMS sensor and actuator array distributed along the leading edge of a model aircraft wing creating rolling moments of sufficient strength to control aircraft flight, pointing the way to future fighter aircraft with advanced maneuverability unattainable using conventional, large and discrete control surfaces; a demonstration of a MEMS-based accelerometer capable of surviving and operating in the near 100,000 G accelerations generated by firing artillery shells, making possible affordable guidance systems to what are presently unguided munitions and increasing both their effectiveness and life cycle costs; and the establishment of a regularly scheduled, shared, MEMS fabrication service for domestic DoD, commercial

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and academic users. The service has lowered barriers to access and has allowed hundreds of researchers, students and industrial users, nearly half for the first time, to inexpensively and rapidly fabricate MEMS devices.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Achieved factor of 3-5x increase in electronics-to-mechanics integration ratios with new fabrication processes; began development of related information-driven and fault-tolerant designs for devices; began incorporation of extreme condition materials into sensor and actuator designs. ($6.9M)
- Achieved 200-300 mechanical components/sq cm systems densities with associated increases in both process yields and device performance uniformities; began exploration of new organization and control strategies for multiple, heterogeneous and distributed MEMS components; continued development of complete and stressing MEMS systems demonstration projects in areas such as fluid vortex control, adaptive optics, combustion control and atomic-resolution mass-data storage. ($16.4M)
- Extended distributed shared fabrication services to enable process experimentation; continued development of fabrication, packaging and metrology tools to address devices and systems developments; expanded available set of shared fabrication processes and associated CAD tools and design libraries. ($7.1M)

(U) FY 1997 Program:

- Achieve additional factor of 5-10x increase in electronics-to-mechanics integration ratios; explore space of related device designs and architectures enabled by order-of-magnitude increase in integration ratios including electromechanical signal processing elements and radio-frequency components; continue development of fault-tolerant and parallel designs including low-noise, low-drift multi-axis accelerometers and gyroscopes; demonstration of extreme temperature and pressure sensor function in operational environments. ($9.7M)
- Achieve 400-500 mechanical components/sq. cm systems densities with integrated or hybrid fabrication/assembly techniques; demonstrate MEMS applications using massively parallel MEMS components; initiate new dual-use areas including analytical instruments, precision assembly, on-demand structural strength enhancement and air-vehicle aerodynamic control; begin creation of shared testbed for development and validation of new organizational and control strategies for large-scale, distributed MEMS. ($25.2M)
- Initiate MEMS Plasma Processing development. ($4.9M)
- Initiate Peizoelectric MEMS development. ($2.0M)

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technologies, PE 0603739E, Project MT-12

- Begin transition of mature fabrication services to self-sufficiency; demonstrate scalable distributed fabrication services for MEMS process experimentation; continue development of MEMS-specific unit processes and associated processing equipment; continue the extension of simulators to address the modeling and coupling of multiple physical forces encountered in MEMS applications; continue dissemination and validation of CAD tools and design libraries. ($6.9M)
- Initiate plans to develop on-chip integrated microfluidic systems for improved detection and control of molecular reactions with emphasis on the development of new materials and control of reactions. ($13.5M)

(U) FY 1998 Program:

- Devices and Processes - Accelerate and expand on MEMS systems developments that exploit physics and MEMS systems architecture to project micro-scale actions into macro-scale effects such as micro-optomechanical scanners, switches, displays, adaptive optics and aligners. ($12.5M)
- System Design and Development - Extend present fabrication processes to cost-effective, large area fabrication approaches. ($32.3M)
- Support and Access Technologies - Integrate developments in MEMS, robotics and ultra-electronics to design, construct and field multiple, high-performance, mobile, autonomous systems. ($9.3M)
- Microfluidics - Initiate system-level integration through an evolving testbed strategy in which the development of new microfluidic components and processes occurs concurrently with the integration of early prototypes with available chip-based molecular analysis components. Leverage analysis and detection technology from industry, Services, and other DoD programs when compatible with microsystems integration. ($18.0M)

(U) FY 1999 Program:

- Devices and Processes - Demonstrate radio-frequency electromechanical filtering, processing, and beam steering and atomic-resolution data storage using precision, parallel read/write structures. ($10.0M)
- System Design and Development - Initiate concept demonstrations for systems in the form of model aircraft and weight-supporting structures, and additional concepts in areas including identify friend-or-foe systems, on-chip chemical processing, and mobility. ($34.5M)
- Support and Access Technologies - Address the key barriers in MEMS fabrication, packaging and integration to realizing systems demonstrations that will be critical to DoD validation and insertion of MEMS technology. ($11.0M)
- Microfluidics - Continue system-level integration on new microfluidic components and processes. ($16.0M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Advanced Electronics Technologies, PE 0603739E, Project MT-12

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	31.0	54.8	65.1	66.5
Appropriated	30.2	59.2	N/A	N/A
Current Budget	30.4	62.2	72.1	71.5

(U) **Change Summary Explanation**:

FY 1996 Increase is due to minor program repricing.
FY 1997-99 Increase reflects increased efforts in microfluidic systems and enhancements to MEMS.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 97	Navigation-grade inertial measurement and guidance devices.
Jun 97	VGA-resolution monochrome grating light-valve display.
Sep 97	25k Tracks/in magnetic recording with dual-stage actuators.
Jan 98	Self-sufficiency of mature shared fabrication services.
Jun 98	Controlled chemical reactions and processing on chip.
Jan 99	Atomic-resolution data storage using precision, multiple read/write structures.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Maritime Technology
PE 0603746E, R-1 #49

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Shipbuilding Technology MR-01	46,351	49,021	37,408	12,592	0	0	0	0	0	N/A

(U) **Mission Description:** The goal of the MARITECH Program is to preserve the U.S. shipbuilding industrial base by improving the industry's commercial competitiveness through advanced technology applications. For the Defense Department, a competitive shipbuilding industry optimizes Navy ship acquisition reform and allows realization of the Department's objective for affordable Navy ships. The goal of the DoD Acquisition Reform Program is to take advantage of the best commercial practices of industry and thereby achieve cost reductions of the ships and systems it purchases. Having operated exclusively in a protected domestic market, the U.S. shipbuilding industry has not implemented the best commercial processes necessary to compete in the international arena or to build affordable Navy ships. The government's attempt at acquisition reform, as it applies to ship acquisition, could fall short if U.S. shipyards are not commercially competitive. The key for acquisition reform is for the U.S. shipbuilding industry to attain global commercial competitiveness.

(U) This is a two-phased program that provides products and infrastructure for the near and long term. The near term effort enhances international competitiveness through the development of a portfolio of U.S. ship designs for the international marketplace and the build strategies for their competitive price and delivery. This effort is being enhanced by developing an infrastructure that includes the implementation of electronic communications and commerce throughout the industry, and by participating in an industry-wide forum for problem solving on a technical level.

(U) The long term effort includes the infusion of innovative product technologies and process improvements that brings the capabilities of the U.S. shipbuilding industry above those of foreign shipyards. This will result in a larger share of the international market, and a self-sustaining, highly efficient U.S. shipbuilding industry.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Completed shipbuilding strategy development initiatives and new ship designs begun in FY 1994. ($13.5M)
- Completed advanced technology development initiatives started in FY 1995. ($8.2M)
- Established a National Shipbuilding Consortium. ($.6M)

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- Commenced Electronic Commerce Computer Integrated Enterprise for Maritime community. ($3.4M)
- Continued to improve and expand National Shipbuilding Network (NSnet). ($.9M)
- Commenced six initiatives for advanced shipbuilding strategy development and new commercial designs. ($5.6M)
- Commenced five initiatives for advanced technologies to radically improve ship production processes and products. ($7.9M)
- Investigated applicability of Advanced Materials to hull construction. ($2.7M)
- Commenced development of standard data exchange translators for digital ship design and construction. ($3.6M)

(U) FY 1997 Program:

- Complete advanced technology developments for improving ship production processes and products initiated in prior years. ($8.6M)
- Continue advanced technology developments started in FY 1996. (9.4M)
- Continue to improve and provide support for National Shipbuilding Network (NSnet). ($.6M)
- Expand Electronic Commerce and Computer Integrated Enterprise. ($4.1M)
- Support National Shipbuilding Consortium. ($.9M)
- Complete funding of all advanced shipbuilding strategies and commercial ship design initiatives from prior years. ($7.9M)
- Initiate advanced technology demonstration projects in the areas of Total Process Systems and Advanced Business Practices. ($17.5M)

(U) FY 1998 Program:

- Continue Total Process Systems development projects initiated in FY 1997. ($11.8M)
- Continue Advanced Business Practices development projects initiated in FY 1997. ($15.6M)
- Complete development of standard data exchange translators for digital ship design and construction. ($3.3M)
- Complete advanced technology development projects initiated in FY 1996. ($3.6M)
- Complete Electronic Commerce and Computer Integrated Enterprise project commenced in FY 1996. ($3.1M)

(U) FY 1999 Program:

- Complete Total Process Systems development projects initiated in FY 1997. ($6.3M)
- Complete Advanced Business Practices projects initiated in FY 1997. ($6.3M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Maritime Technology, PE 0603746E, Project MR-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	47.2	37.4	50.0	0
Appropriated	48.1	49.0	N/A	N/A
Current Budget	46.4	49.0	37.4	12.6

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia supplemental rescissions.
FY 1998-99 Program rephased to reflect anticipated expenditure patterns.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Sep 97	Complete development of 15 process and product technological innovations focused on aiding the U.S. shipbuilding community to compete internationally.
Sep 97	Complete seven additional ship designs for the international commercial marketplace.
Mar 98	Complete evaluation of Integrated Product Data Environment for Shipbuilding.
Jun 98	Complete test and evaluation of System Life Cycle Support Infrastructure Demonstration Project.
Sep 98	Complete final 6 ship designs for International Commercial marketplace.
Jul 99	Complete prototype demo and development of commercialization plan for next Generation PC based system for Integrated Product and Process Development.
Jul 99	Complete development of National Shipbuilding Information Infrastructure Protocols.
Dec 00	Complete all Total Process Systems and Advanced Business Practices projects commenced in FY 1997.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Electric Vehicles PE 0603747E, R-1 #50

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Electric Vehicles EV-01	14,694	14,707	0	0	0	0	0	0	0	N/A

(U) **Mission Description**: Electric and hybrid electric drivetrains provide compelling advantages for future tactical and combat vehicles. Of particular importance is a 50-percent reduction in fuel consumption due to higher efficiency, improved acceleration and maneuverability due to immediate torque to the wheels or tracks, and dramatically reduced thermal and acoustic signatures when operating from on-board energy storage. Affordability is addressed through reduced logistics requirements and the dual use applications of these technologies.

(U) The DARPA Electric and Hybrid Vehicle Technology program is pursuing research, development, and demonstrations of technologies for electric and hybrid vehicles that address military missions, modernization, and cost mitigation. Established by Congress in FY 1993, the program has pursued technology development and prototype demonstrations that are essential for future military systems, enhancing national energy security, and facilitating compliance by the Armed Services with federal clean air legislation. DARPA uses a unique decentralized management approach working directly with seven regional consortia. These diverse consortia provide a minimum of 50% of the funding and cooperatively function to overcome the challenges of developing electric and hybrid vehicle technologies. Consortium participants include military laboratories and bases, state and local governments, large and small defense contractors, well-established and startup manufacturers of vehicles and components, electric and gas utilities, public interest groups, and universities. Military requirements and infrastructure are implemented within this program at minimal federal investment, leveraging significant funds.

(U) Technology development is focused on: High-specific power engine/generator sets, including multi-fuel capable, high efficiency, and low emissions turbines, diesels, and rotary engines; Power control devices, including high-performance power semiconductors, control algorithms, and circuit integration and packaging; Energy storage devices, including advanced batteries, rapid battery recharging, flywheels, and capacitors; Electromechanical conversion, including alternating current and direct current, and linear motors; and Lightweight high-strength materials, including space-frames and composites. These dual-use electric drivetrain technologies are being demonstrated in both commercial and military chassis. The technologies are directly relevant and are coordinated with the DARPA Combat Hybrid Power Systems program (budgeted under LNW-01) which is developing an integrated electric power system to provide both continuous and pulsed power to all of the subsystems on a combat vehicle including weapons, C3I, countermeasures as well as the electric drivetrain developed in this program.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Electric Vehicles, PE 0603747E, Project EV-01

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Demonstrated hybrid electric drivetrains in Bradley Fighting Vehicle and High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and design drivetrain upgrade for Composite Armored Vehicles. ($1.7M)
- Demonstrated upgraded M113 Armored Personnel Carrier and USMC/SOF Vehicle Drivetrains. ($1.8M)
- Demonstrated hybrid and electric drivetrains in 40 ft buses (1 ea.), 31 ft buses (3 ea.), 22 ft buses (3 ea.), delivery van (1 ea.), refuse truck (1 ea.) and 64 ft Small Water-Plane Twin Hull (SWATH) boat (1 ea.). ($1.8M)
- Developed flexible manufacturing technology and cost reduction practices for composite materials to support affordable, high strength, lightweight chassis. ($2.4M)
- Developed technology for affordable electric and hybrid vehicle drivetrains including: prime power, energy storage (high power batteries, flywheels and ultracapacitors) and motor/controllers. ($4.0M)
- Developed battery management systems, rapid battery chargers and technology for cold weather operations. ($3.0M)

(U) FY 1997 Program:

- Develop and field test hybrid electric combat vehicles. ($2.0M)
- Develop improved auxiliary power unit (APU) and integrate into medium and heavy hybrid electric vehicles. ($3.0M)
- Build and test flywheel energy storage units with containment. ($4.0M)
- Develop reliable battery management systems with rapid charging. ($2.0M)
- Develop and test improved motors and motor controllers. ($2.0M)
- Complete development of electric/hybrid drivetrains for medium/heavy duty chassis. ($1.0M)
- Complete Hybrid Electric Drive simulation and modeling. ($.7M)

(U) FY 1998 Program: N/A

(U) FY 1999 Program: N/A

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)

DATE February 1997

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Electric Vehicles, PE 0603747E, Project EV-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	0	0	0
Appropriated	15.0	14.7	N/A	N/A
Current Budget	14.7	14.7	0	0

(U) **Change Summary Explanation**: N/A

FY 1996 Decrease reflects Bosnia supplemental rescission.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Jul 97	Demonstrate hybrid electric propulsion of a High Mobility Multi-purpose Wheeled Vehicle (HMMWV).
Sep 97	Demonstrate hybrid electric propulsion of a Bradley Fighting Vehicle (BFV).
Jun 98	Complete field test of BFV and HMMWVs.
Sep 98	Demonstrate improved motor and controller.
Sep 98	Complete and distribute hybrid vehicle model.
Dec 98	Complete initial test of flywheel and containment in heavy-duty vehicle.
Dec 98	Complete testing of battery management system with rapid charging.

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DATE February 1997

APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Command, Control and Communication Systems,
PE 0603760E, R-1 #55

COST (In Thousands)	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Command, Control and Communication Systems	**0**	**102,996**	**163,800**	**172,600**	**190,369**	**212,234**	**219,034**	**219,034**	**Continuing**	**Continuing**
Command & Control Information Systems CCC-01	0	44,485	67,376	67,100	80,369	91,234	100,234	99,034	Continuing	Continuing
Information Integration Systems CCC-02	0	58,511	96,424	105,500	110,000	121,000	118,800	120,000	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Advanced Technology Development Budget Activity because its purpose is to demonstrate and evaluate advanced information systems research and development concepts. The FY 1996 funding for these programs was previously budgeted in the Experimental Evaluation of Major Innovative Technologies, PE 063226E.

(U) The Command and Control Information Systems project is developing the technologies necessary to facilitate joint campaign planning and control throughout the battlespace. The primary program in this project is the Joint Forces Air Component Command System (JFACC), that will improve air combat coordination and targeting from initial planning through Air Task orders. Other programs addressed in this project includes: the Integrated Battlespace program, the Advanced Joint Planning (AJP) advanced concept technology demonstration, the Advanced Cooperative Collection Management (ACCM) program and the Speakeasy program.

(U) The Information Integration Systems project will develop the technologies necessary to ensure that the enhanced information required by battlefield combatants is available on a near real time basis. Programs addressed in this project include the Dynamic Multi-User Information Fusion (DMIF) program, the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) ACTD, the Airborne Communications Node (ACN) program, and the Command Post of the Future program.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Command, Control and Communications Systems, PE 0603760E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Command Control Information Systems CCC-01	28,510*	44,485	67,376	67,100	80,369	91,234	100,234	99,034	Continuing	Continuing

* The FY 1996 program was previously budgeted in Program Element 0603226E (Projects EE-21 and EE-40).

(U) **Mission Description**: Recent military operations, e.g., Desert Storm and Haiti, demonstrated that current theater command, control, communications, intelligence/information systems, planning and rehearsal systems, and non-lethal weapon's capabilities lack the ability to support effective operations in diverse new arenas and scenarios ranging from desert heavy battle to urban areas with large civilian populations. Current capabilities do not provide real-time situational awareness, decentralized battle planning, rehearsal and execution capability, flexible interfaces or critical interoperable wide-area communications. The goals of the programs in this project, described individually below, are to enhance information processing, dissemination and presentation capabilities for the Commander by inclusion of information pertaining to enemy and friendly forces, providing a joint situational awareness picture and improving planning, decision-making and execution support capability and providing multi-media information interfaces and software to "on-the-move users". Integration of collection management, planning and battlefield awareness programs is an essential element of our strategy for achieving battlefield dominance through information systems.

(U) The Joint Forces Air Component Commander (JFACC) Program seeks to revolutionize command and control (C2) of joint and coalition air forces through the incremental development, integration, evaluation, demonstration and transition to the Warfighter of technology and systems which will enable new operational concepts for planning and execution that will significantly improve the responsiveness, efficiency and effectiveness of air operations. Key aspects of the program are: Continuous near-real-time planning and execution with all tasks tied to a central strategy; collaboration among distributed elements to achieve a high degree of integration through the echelons and across operations, intelligence and logistics; and end-to-end management of C2 operations including advanced capabilities for strategy development, target systems analysis, campaign assessment and resource planning. Key technologies include: Centrally managed, multi-stage, concurrent plan generation; planning agents; intelligent resource scheduling techniques; dynamic resource reallocation algorithms; adaptive cueing tools; automated information routers; information tailoring and visualization tools and advanced collaborative and workflow management tools. These technologies will be applied to requirements that include: Continuous mission planning processes which

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quickly anticipate and react to changes in threat situation, resource availability and synchronization needs; full integration of intelligence and operational activities to support strike operations and prioritized target nomination; empowerment of cross functional product teams to quickly respond to changes; and proper battlefield knowledge to support activities and decisions at multiple echelons. JFACC technologies will be extended to maritime and land component C2 systems supporting joint force operations and associated planning tools will be made interoperable with related DARPA and Service programs (e.g. Advanced Logistics Program -- ALP, Advanced Cooperative Collection Management -- ACCM, and Battlefield Awareness and Data Dissemination -- BADD). Program execution features a multi-phased, develop-demonstrate-transition approach, including close coordination with the Air Force and the Theater Battle Management Core Systems (TBMCS) development program which will serve as a near term precursor to the more revolutionary JFACC program.

(U) The Integrated Battlespace (IB) Program will extend emerging information technologies and develop new methods to integrate joint force planning tools and operations management software applications. IB focuses on extending capabilities across service components (e.g., air, land, maritime) as well as between functional components (e.g., intelligence, operations, logistics, command-and-control warfare). IB will leverage technology from the JFACC program, Advanced Logistics, Planning and Decision Aids, and Genoa to coordinate and synchronize joint operations. IB will develop technology to support force allocation decision-making based on the CINC and Joint Task Force Commander's intent.

(U) With the growing dependence on information systems and the pressing need to be able to get the right information to the right person at the right time, it becomes critical to deliver and protect information and assure the availability of associated services -- particularly in a stressed environment. Information assurance technologies will be integrated into future versions of the Defense Information Infrastructure (DII) Leading Edge Services (LES) to provide a robust architecture across a wide range of DoD information systems. The development and fielding of secure information systems will be a continuing process of development and upgrading of existing systems and capabilities. The initial investment provides: near term applications to provide a modest level of protection; a testbed to test and evaluate available commercial and government applications and procedures; and a mechanism to test advanced secure information development in an end to end environment.

(U) Emerging technologies in Command and Control promise significant enhancements in operational readiness, planning and crisis response. The Advanced Joint Planning (AJP) ACTD seeks to evolve selected advanced planning tools, in a distributed collaborative environment at US Atlantic Command (USACOM), to evaluate the potential for enhancing Battle Staff Command and Control capabilities. Based on the evaluation results of this selected subset of

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planning tools, a full set of tools will be integrated into the USACOM Battle Staff Planning System. This "leave behind" system will form the model for upgrades to other CINC Planning Systems.

(U) A new generation of collection systems will provide dramatically increased volumes of higher fidelity data to the operational decision maker. The challenge will be to dynamically manage and synchronize this advanced collection architecture with the processing, exploitation, and dissemination capabilities to provide the critical information to the decision maker in the constantly changing operational situation. The conventional requirements management, tasking, collection, processing, and exploitation process is unable to support the dynamics of a constantly changing operational environment. The Advanced Cooperative Collection Management (ACCM) Program will expand on efforts begun under the JFACC program and develop Continuous Asset Planning, Automatic Tasking, and Multi-asset Synchronization capabilities which will provide the collection management tools required to dynamically optimize/synchronize, schedule, and task the spaceborne, airborne and ground based collection, processing, exploitation and dissemination architecture. Collection Management (CM)-Link will optimize the architecture's capability to effectively support multiple operational users simultaneously by providing all echelons with: A common view of the collection environment; current status of collection, processing, exploitation, and dissemination operations; faster than real-time simulations in support of trade-off decisions; and the ability to conduct real-time multi-echelon coordination and shared decision making. ACCM is coordinating closely with the DIA Integrated Collection Management ACTD and the Joint Collection Management Tools acquisition program which will be recipients of DARPA technology as it matures.

(U) The Speakeasy Program will demonstrate a software-programmable communication system in a tactical environment. Speakeasy, which operates over the 2 Mhz to 2 Ghz band, provides the capability to implement wireless communications concepts to meet Service requirements. Speakeasy is an open architecture-based, software-programmable communications terminal supporting simultaneous operation on a minimum of six radio frequency waveforms (four programmable channels in addition to ones for the global positioning system and cellular). The program is transitioning to the Services in FY 1998 after an operational demonstration of the system during the Task Force XXI exercise in FY 1997.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Accomplishments:

- Conducted phase one "proof-of-concept" warfighter demonstration of prototype components at the USAF Battle Management Battle Lab, Hurlburt AFB, FL in Jan 97. Prototype components included: Air operations resource

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allocation and scheduling tools, campaign assessment process, workflow management control of the planning process, ISR and logistics planner, and target system analysis toolset. Initiated second phase of system development -- basic technology/application building blocks and system architecture for the "JFACC After Next" Concept. ($19.6M)

- Defined information survivability threats, from internal failures or external attacks. ($2.0M)
- Developed threat-based design strategies and required near-term product extensions. ($5.2M)
- Defined standard information warfare (IW) attack set to measure progress towards attack resiliency. ($2.0M)
- Based on prior year evaluation, completed the design, accomplished modifications and installation of a "leave behind" operational system, which can then be replicated for other CINCs. First version of map based planner was released in Dec 96. ($9.0M)
- Completed the development of several waveforms, i.e. SINCGARS (VHF), HAVE QUICK (UHF), HF Single Side Band, UHF SATCOM, and the Air Traffic Control (VHF) and demonstrated capability at the National Training Center in the Army Task Force XXI Advanced Warfighting Experiment (AWE) by the 1st Brigade 4th Infantry Division. ($6.7M)

(U) FY 1998 Program:

- Demonstrate and evaluate the basic technology/application building blocks and system architecture for the "JFACC After Next" Concept (Phase 2). Develop Phase 3 capabilities - an initial integrated campaign management and continuous planning and execution ability. Develop the combined benefit of target systems analysis and campaign assessment leading to an increase in mission cost effectiveness by a factor of three. Demonstrate interoperability with TBM Core Systems and the DII. ($32.7M)
- Develop initial integrated joint force planning tools and operations management software applications for maritime and ground forces components compatible with DII. ($3.0M)
- The robust architecture testbed will demonstrate automated capabilities to limit system access, and prevent system attacks by layering privacy security service for end-to-end and filtering out active code that is dangerous to enclave systems. Demonstrate gross responses for disabling attacks by shutting down outside connection and system-wide recovery. Demonstrate mechanism interoperability with negotiation protocols and good system administration tools to manage security mechanisms in GCCS LES. Integrate a basic Public Key Infrastructure certificate management system to support basic security services. Demonstrate basic replication techniques and anti-flooding techniques. ($20.0M)
- Expand the Advanced Cooperative Collection Management (ACCM) functionality beyond the JFACC ISR Planner to include information needs management and dynamic, multi-asset allocation. Begin technology transitions into

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DOD collection management migration systems. Demonstrate emerging ACCM functionality with Service transition partners and integrate fully with the DIA ACTD on Collection Management. ($9.6M)

- Complete the transition and support to the operational Advanced Joint Planning ACTD to USACOM. ($2.1M)

(U) FY 1999 Program:

- Demonstrate, evaluate and initiate transition of Phase 3 capabilities to Warfighters. Develop Phase 4 capabilities - a robust, integrated campaign management and continuous planning and execution capability that achieves 70% of all responsiveness, resource efficiency, campaign effectiveness and process flexibility goals. Develop initial transition of JFACC capabilities to maritime and ground forces components and full DII compatibility. ($37.1M)
- Demonstrate automated capabilities to limit system access, protect data, manage replication and recovery, detect and respond to intrusions, and reconstitute/reconfigure information services to reflect dynamic operational priorities. Demonstrate capability to do integrated monitoring of network service data, detected intrusion status and configuration/reconfiguration and to manage allocation of components and resources dynamically to reconstitute critical functions that have been degraded. ($20.0M)
- Demonstrate initial proof-of-concept of Continuous Asset Planning, Automatic Tasking, Multi-Asset Synchronization and CM-Link in the Roving Sands 99 exercise. ($10.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	28.5	47.8	57.3	62.1
Appropriated	N/A	41.2	N/A	N/A
Current Budget	28.5	44.5	67.4	67.1

(U) **Change Summary Explanation**:

FY 1997 Increase reflects reprogramming and realignment of funds to establish integrated testbed for existing programs.

FY 1998-99 Increases reflect additional funding requirements for the Integrated Battlefield and integrated testbed.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 97	Support Task Force XXI Advanced Warfighting Experiment.
Apr 97	ACCM Concept Validation demonstration to user community, including benefit of multiple asset management.
Sep 97	Complete the design, accomplish modifications and installation of "leave behind" AJP-ACTD operational systems.
Sep 97	Define IW attack set to measure progress towards attack resiliency.
Mar 98	Demonstrate JFACC Phase 2 - prototype JFACC planning and execution infrastructure/tools.
Jul 98	Integrate COTs security, security APIs, and detect intrusion tools in GCCS LES Release 3.x
Sep 98	Demonstrate continuous asset planning and automatic tasking with U-2, Dark Star, and Global Hawk.
Sep 98	Demonstrate automated capabilities to limit system access, protect data, manage replication and recovery, detect and respond to intrusions, and reconstitute/reconfigure information services.
Dec 98	Detect 80% of IW attack set, disable attacks by shutting down outside connection and system-wide recovery by system rollback to condition prior to attack.
Apr 99	Demonstrate proof-of-concept ACCM capabilities in Roving Sands 99.
Mar 99	Demonstrate JFACC Phase 3 - integrated campaign management and continuous planning and execution capability.
Sep 99	Integrate a basic Public Key Infrastructure certificate management system to support basic security services. Demonstrate basic replication techniques and anti-flooding techniques (port filtering).

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Command, Control and Communications Systems, PE 0603760E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Information Integration Systems CCC-02	(35,161)*	58,511	96,424	105,500	110,000	121,000	118,800	120,000	Continuing	Continuing

* The FY 1996 program was previously budgeted in Program Element 0603226E (Projects EE-21 and EE-40).

(U) **Mission Description:** The goals of this project are to take diverse inputs, including those planned as outputs from the PE 06063762E Sensors and Exploitation Systems Project (SGT-04), and perform distributed and dynamic all-source correlation and fusion to produce an integrated, geo-spatially referenced, battlefield database and knowledge-base, and through the use of wideband dissemination and integrated sensor management allow multi-site, real-time, collaborative situation assessment and course-of-action evaluations. These goals are being addressed by the Dynamic Multi-User Information Fusion (DMIF) project, the Dynamic Database (DDB) program, the Battlefield Awareness and Data Dissemination (BADD) ACTD, the Airborne Communications Node (ACN) project, and the Command Post of the Future program.

(U) The Dynamic Multi-User Information Fusion (DMIF) program is the premiere fusion advanced technology development program for the defense and intelligence communities, including next-generation automated capabilities to support the operational service fusion systems: ASAS, TBMCS/CIS, and JMCIS. The program is developing and inserting a product line of fusion capabilities that combine information from multiple sensor-based sources (eg, TIBS broadcasts, SAIP outputs, HUMINT reports, and Binocular SIGINT information) as well as outputs from multiple fusion engines (such as those resident within TBMCS, ASAS, the Common Ground Station (CGS), or Regional SIGINT Operations Centers (RSOCs)). Any given insertion of DMIF would combine, focus, and rectify information from these disparate sources to provide the joint warfighter with a clear and actionable picture of the battlespace. This DMIF-created picture will drive information across the ops-intel divide. In current GCCS transition plans, DMIF will populate the database (Situation Object Repository) that provides a real-time mission focused picture of the battlespace (via the Situation Server) to all requesting applications. More generally, DMIF is building a series of low-cost applications (Product Finishers) to provide "finished" information products to a wide variety of ops systems, including applications for targeting, SEAD, maneuver control, and logistics planning. In all these efforts, a key DMIF program objective and measure of success is focused, rapid and effective transition of advanced fusion technology to warfighters via technology transition efforts already underway with key service C4I programs.

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(U) The Dynamic Database (DDB) program will expand on work begun under DMIF and SAIP (SGT-04) to develop the technology to maintain a Dynamic Situation Model by indexing all relevant information about the battlespace according to geospatial and other attributes, at the entity (e.g., vehicles and combat units), terrain, and signal feature level. The database will be able to store selected imagery and annotations, three dimensional site models, battlefield entities and relations, terrain parameter maps, and physical and signal features from imagery and terrain generation applications, all aligned and indexed for rapid, common access. Methods for updating and accessing the Dynamic Situation Model will be provided. The program will also develop the database services needed by users and applications, including DMIF and BADD, such as near real time generation of current terrain features, entities, and properties such as lines of communications, change detection, line-of-sight and terrain suitability calculations, and trafficability analysis.

(U) The objective of the Battlefield Awareness and Data Dissemination (BADD) Advanced Concept Technology Demonstration (ACTD) is to deliver, install and evaluate an operational prototype system that delivers to warfighters a consistent operational picture of the joint/coalition battlefield, allows commanders to design/tailor their own information system, and provides access to key transmission mechanisms and worldwide data repositories. The description of the battlespace provided to the warfighters under this ACTD will be tailored to their mission needs by intelligent selection of information to be broadcast, intelligent processing of user requests (pull) and filtering at the warfighter workstation so that needed information is available. BADD will be evaluated through participation in exercises and demonstrations, and by insertion into ongoing pilot services, such as the Joint Broadcast Service installed in the European Theater in April 1996. BADD is also operating under a Memorandum of Agreement with the Global Broadcast Service Program Office to provide advanced information management capabilities and new applications for this system as part of the overall plan of transition of BADD developments to operations after test and evaluation in the ACTD. Selected applications and dissemination services will be transitioned to the Defense Information Systems Agency (DISA) for incorporation into the Defense Information Infrastructure Common Operating Environment (DII/COE).

(U) The Airborne Communications Node (ACN) program will provide range extension and rapid deployment for many new and existing military communications systems. This is achieved through the placement of a highly flexible radio communication system on the Global Hawk High Altitude Endurance unmanned airborne platform. The ACN will connect isolated and rapidly maneuvering forces with high data rate communications, provide reach-back connectivity to CONUS from forward elements, and allow gateway connectivity among dissimilar radios. The program will conclude with field demonstrations in FY 2000.

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(U) The objective of the Command Post of the Future program is to develop and evaluate a tailorable, deployable integrated command and control information environment that adds significant value to the operational Commander in the field. The system design will be based upon an understanding of how to display information to enhance the assimilation and understanding of a wide range of warfare scenarios. Currently employed Command Posts operational support systems do not have the capacity nor technology to provide an effective decision support environment for the rapidly changing, multi-dimension battlespaces of today's and tomorrow's missions. The Command Post of the Future will address these shortcomings by exploiting leading edge technologies found in industry, at research facilities and those technologies that DARPA is currently developing (JTF ATD, JFACC, BADD and Dynamic Database/DMIF, ALP and the technology programs HPKB, I*3, CVIM, HCI, PDA). This will enable the commander of the future to enter a CP that in today's terms is a world of virtual reality. This CP will go beyond flat displays of text, 2D graphics and video to rapidly shift this paradigm and to move to a 3D representation where the commander will "move" about the battlespace in a virtual 3D world generated with intelligent presentation synthesis, be able to consult with his superiors and subordinates via real-time interactive conferencing, and have a natural language interface and high-precision information retrieval.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Dynamic Multi-User Information Fusion (DMIF) program: Develop and demonstrate, with Service transition partners, adaptive fusion processes and services for providing tailored situation representations which facilitate technology insertions and functionality through a broad spectrum of operating environments. Initiate the construction of a simulated test environment for early assessment of user requirements and operational concepts, for performance evaluations and validation of fusion engines, and for easy integration with other developmental and Service information systems. Continue the insertion begun in FY 1996 of DMIF capabilities into the Combined Air Operation Center (CAOC) in Vicenza, Italy. Perform pilot experiments, system performance definition, and entity-level development for a Dynamic Database. Demonstrate a prototype stand alone, multi-source, inference-based fusion system for a limited target set at a major joint operations center, and migrate that system toward an open, agile, and robust architecture to promote interoperation with existing ops/intel battlefield information systems. ($18.1M)
- Battlefield Awareness and Data Dissemination (BADD) ACTD: Participate and be evaluated in Task Force XXI Army Warfighting Experiment. Demonstrate system capabilities in a series of demonstrations, including a joint demonstration (called the Joint Forces Integration Demonstration) involving Navy, Marine and Air Force

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elements. Capabilities and services to be evaluated include: Information Dissemination Manager node located in Washington, DC; Warfighter's Associate terminals in use by the Army at Fort Irvin, at 29 Palms by the Marines, and at Camp Pendleton/NRaD by the Navy and Marines; leased GBS commercial satellite communications interfaces; creation and dissemination of an operational picture of red and blue force status; and dissemination of integrated imagery, video, signals intelligence, terrain, weather, Global Command and Control System (GCCS) and Maneuver Control System (MCS) data. Participate and demonstrate enhanced functionality in various demonstrations (Systems Integration Laboratory, JWID 97, and demonstrations in Korea/PACOM) conducted by the Phase II system integration contractor. Enhancing legacy systems focusing on improving the bandwidth utilization and expanding the user base to include additional major military commands is another objective. Efforts during this fiscal year culminate in the delivery of an operational capability supporting CONUS based users and enhancements to the current capability supporting OCONUS users. ($31.7M)

- Airborne Communications Node (ACN): Conduct technology development of advanced devices and antennas to facilitate the access of multiple hand held communications devices, start integration of several key enabling technologies (e.g. software radios, common hardware modules and high-speed fiber optic communications infrastructure), develop innovative EMC/EMI mitigation techniques to enable simultaneous operation across the frequency spectrum, VHF to Ku bands. Initiate synthesis of advanced technologies and commence design of the ACN payload. ($8.7M)

(U) FY 1998 Program:

- DMIF: Continue development of the DMIF system to implement an adaptive fusion management architecture which performs real-time context-sensitive fusion engine tasking. This tasking would adapt to the characteristics of available or incoming information, the performance of the available information processing applications (such as ASAS, Quarterback, CIS AA, or RADIANT JADE), and the specific tactical situation (as represented by the commander's critical intelligence requirements or via automated planning systems). Demonstrate improved performance relative to the stand-alone performance of the migration fusion systems being tasked, and improved interoperability compared to the stove-piped operation of the migration systems. Complete first a series of Product Finishers, including those supporting precision targeting and maneuver control, and integrate with ops applications that require real-time focused situation awareness, including JFACC After Next and ASAS Warrior/MCS(P). Transfer entity-level dynamic database capabilities for the FY 1998 initiation of the Dynamic Database program and continue close coordination of these efforts. Demonstrate functionality at multi-service exercises and transition components to DARPA ACTDs (BADD) and to Service and Agency transition partners (Army ASAS, Air Force TBMCS, DISA GCCS). ($13.0M)
- Dynamic Database Program: Expand entity-focused database efforts begun under DMIF by building an integrated

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prototype for consolidated terrain, signal feature, and entity level representation of a Dynamic Situation Model. Build on algorithms and capabilities previously developed under BADD, Semi-Automated IMINT Processing ACTD (funded under EE-50), Intelligent Integration of Information (funded under ST-11) and especially DMIF, including fusion services, integration of multiple information repositories, change detection and site monitoring, and database mediation, to create a united set of reusable software services that can be mediated for general purpose access by many applications, including DMIF, BADD, and SAIP. Provide an initial test article for integration into the Information Systems Office testbed, and provide a baseline for scalable performance estimates. ($19.2M)

- BADD ACTD: Participate and be formally evaluated in an ACOM-conducted joint exercise (Unified Endeavor) increasing the level of automation previously provided to users and extending information management and dissemination support at the level of individual battalions/ships. Provide new information management capabilities to include creation of a 3D graphical depiction of a consistent operational picture by near-real-time integration of all relevant databases, identification and semi-automated resolution of differences building on DMIF technology. Operate a CONUS Pilot Service for ACOM components. Demonstrate and deliver an OCONUS Pilot Service tailored for the Pacific theater. ($47.0M)
- Airborne Communications Node (ACN): Select final design team. Complete payload and unique subsystem design. Select and acquire equipment and modules. Fabricate and assemble payload system and subsystems. Initiate build of System Integration Laboratory (SIL). Commence subsystem Integration and Test. ($14.2M)
- Command Post of the Future: During this fiscal year the program will focus on the design and initial development of an experimental prototype to be used as a proof of concept. This system will integrate multiple data sources, with a virtual reality collaborative work environment where the battlespace entities have been defined as objects within an "object oriented" 3D graphical based system. Each "object" will have the capability to be expanded by the operational commander or his staff to gain supporting data or new perspectives on the current and projected situation. ($3.0M)

(U) <u>FY 1999 Program</u>:

- Continue the development of DMIF functionality to include agile models and distributed, collaborative situation assessment, including: expanded GOB, maneuver control, plan monitoring, SEAD, IPB, and course of action analysis. Extend DMIF architecture to create a product line of fusion systems that work flexibly and seamlessly with existing battlefield information systems within the full GCCS-LES environment. Incorporate DMI products into emerging systems such as BADD. ($8.0M)
- Extend the functionality of the Dynamic Database prototype system to incorporate mature access language, index structure, and search engine capabilities. Incorporate additional common data services, including visibility and change detection computations and flexible trigger, pedigree, and information product

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definitions. Prepare for transition to migration systems, by defining a comprehensive regression and performance test set, developing capabilities for uploading and accessing legacy data, and operating as an overlay on existing systems. ($30.0M)

- BADD ACTD: Continue frequent participation in operational exercises to validate the additional operational capabilities. Examples of increased information management functionality include the creation and dissemination of the consistent operational picture by near-real-time integration of all relevant databases, and identification and automated resolution of differences using DMIF and DDB technology. Provide capabilities to perform resource management of multiple communication paths. Evaluate this capability via participation in a joint demonstration using the Airborne Communications Node (ACN). Operate OCONUS Pilot Service and complete transition of initial CONUS Pilot Services. Enhance the capability to ingest theater sensor data streams, add value by exploitation, and disseminate the raw and enhanced data stream via GBS thereby avoiding the need for many ground sites within line of sight of sensor platforms. ($46.5M)
- Airborne Communications Node (ACN): Complete demonstrations in SIL. Initiate ACN integration into Global Hawk HAE UAV. ($21.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	67.9	90.4	100.3
Appropriated	N/A	61.7	N/A	N/A
Current Budget	N/A	58.5	96.4	105.5

(U) **Change Summary Explanation**:

FY 1997 Decrease reflects minor repricing of the ACN and minor rephasing of the BADD ACTD.
FY 1998-99 Increase reflects funding of key new components for the Dynamic Data Base Program.

(U) **Other Program Funding Summary Cost**: N/A

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(U) **Schedule Profile**:

Plan	Milestones
Oct 96	Demonstrate BADD capability (joint exercise) - Joint Forces Integration Demonstration.
Mar 97	Support Task Force XXI Advanced Warfighting Experiment with BADD technology.
Apr 97	Demonstrate Dynamic Multi-User Information Fusion (DMIF) capability at a major joint operations center. (Previous milestone for FY97 MAJCOM delivery re-baselined, due to FY97 budget reductions. Now part of Sep 98 milestone).
May 97	BADD Phase II System Integration Laboratory (SIL) demonstration.
Jun 97	Demonstrate BADD capability (JWID 97).
Jul 97	Deliver DMIF-I to a MAJCOM.
Sep 97	Complete DMIF testbed for system design, concept of operations and human computer interface development.
Nov 97	Demonstrate DMIF enhanced capability at Division XXI (high value target tracking/projection, hierarchical force assessment).
Nov 97	BADD supports the Army's Division XXI exercises.
Dec 97	Deliver BADD CONUS Pilot Service.
Apr 98	Demonstrate BADD capability (Unified Endeavor 98-2).
Nov 97	Complete ACN Design Tasks.
May 98	Demonstrate DDB prototype in conjunction with ISO testbed.
Jun 98	Complete integration and lab demo of DMIF II and demonstrate interoperability with BADD.
Mar 98	ACN payload Final Design Review.
Jul 98	Support operational exercise OCONUS (PACOM/Korea) and CONUS upgrade for BADD.
Sep 98	Demonstrate DMIF capability to enhance performance of existing intelligence applications (such as ASAS, GCCS, TBMCS) in joint-level simulation of focused situation assessment and operations support.
Sep 98	Complete prototype design of the Command Post of the Future.
Sep 98	Complete ACN Subsystem Development.
Sep 98	Deliver BADD pilot service to OCONUS with DMIF baseline capability.
Dec 98	Bench Test ACN Payload.
Mar 99	Use Dynamic Situation Model from DDB for change detection, situation awareness, and dissemination in laboratory demonstration with SAIP, DMIF and BADD.
Jun 99	DMIF demonstration of distributed comprehensive battlespace awareness in joint-level simulation with service and Agency migration systems (ASAS, GCCS,TBMCS).
Jun 99	ACN SIL Integration and Test Complete.

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Sep 99	Demonstrate technology enhancements to BADD capability (JWID '99).
Dec 99	ACN/Global Hawk Integration and Test Complete.
Jun 00	ACN Field Demonstrations Complete.
Sep 00	Complete BADD transition to DISA, GBS Joint Program Office (JPO) and the Services.
Sep 00	Transition to DISA, ACOM and GBS PO, final operational service.
Sep 00	Demonstrate technology enhancements to BADD capability (JWID '00).

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Communication and Simulation Technology,
PE 0603761E, R-1 #56

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Communication and Simulation Technology	**0**	**127,080**	**75,938**	**72,114**	**46,250**	**51,049**	**54,549**	**49,549**	**Continuing**	**Continuing**
Advanced Simulation CST-01	0	42,548	28,492	26,698	0	0	0	0	0	N/A
Global Grid Communications CST-02	0	52,190	44,566	43,916	44,750	49,549	54,549	49,549	Continuing	Continuing
Defense Simulation Internet CST-03	0	32,342	2,880	1,500	1,500	1,500	0	0	0	N/A

(U) **Mission Description**: This program element is budgeted in the Advanced Technology Development Budget Activity because it's purpose is to demonstrate and evaluate advanced simulation and networking technologies that will seamlessly integrate command and control functions needed for future global defense operations. The FY 1996 funding for these programs was previously budgeted in the Experimental Evaluation of Major Innovative Technologies, PE 0603226E.

(U) The Advanced Simulation project is developing advanced simulation technologies that provide seamless synthetic battlespace that will enable high fidelity simulation across a full range of DoD functions. As technologies mature, they are integrated, tested and demonstrated in excercise/demonstrations of varying size and complexity. Within this project, the Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD) program is developing advanced simulation technologies to provide a seamless synthetic battlespace to support joint training and mission rehearsal activities.

(U) The Global Grid Communications project develops and demonstrates advanced networking technologies needed for global defense operations in the 21st century. Network services will be developed in order to support geographically dispersed staff for crisis management and to support warfighters in rapid deployment, highly mobile scenarios. The program requires the design, adaptation and development of new internetwork protocols. The three main efforts in this project are: (1) The Joint Task Force Advanced Technology Demonstration (JTF-ATD) of a rapid Commander Joint Task Force (CJTF) crisis response capability for a range of situations from multiple regional conflicts (MRCs) to operations other than war (OOTW) capable of being established and operational in days; (2) the Airborne Communications Node (ACN) program which will develop and demonstrate a mobile wireless backbone communications network consisting of multiple airborne nodes which in turn connect to users and networks on the ground, on the

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ocean, and in the air, and (3) The Broadband Information Technology (BIT) program seeks to develop the all-optical multiple wavelength transmission and networking technologies.

(U) The goal of the Defense Simulation Internet (DSI) program is to research, develop and test at scale (worldwide), a network infrastructure capable of enabling distributed, real-time, multi-media (video, voice, shared data and work spaces) simulation that will seamlessly integrate all simulation, modeling, command and control functions from early design to battle rehearsal enroute to the conflict. The DSI will transition to the Defense Information Systems Agency (DISA) Defense Information System Network (DISN) by the end of FY 1997 and be operated on a reimbursable basis.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Communication and Simulation Technology, PE 0603761E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Simulation CST-01	(61,065)*	42,548	28,492	26,698	0	0	0	0	0	N/A

*The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies, PE 0603226E (Project EE-37).

(U) **Mission Description**: The strategic environment in which the United States operates will require Joint Forces to operate across the full spectrum of conflict. At the same time, resources will continue to shrink, requiring the Department to search for the most cost effective means to perform the full spectrum of defense functions. To support the National Military Strategy, the Advanced Distributed Simulation (ADS) program is developing advanced simulation technologies that provide seamless synthetic battlespace that will enable high fidelity simulation across a full range of DoD functions, e.g. Joint/Service readiness training and mission rehearsal; Joint/Service doctrine development and refinement; requirements analysis; design and prototyping; and operational/tactical planning. As technologies mature, they are integrated, tested and demonstrated in exercises/demonstrations of varying size and complexity. Within the ADS Programs the Synthetic Theater of War (STOW) Advanced Concept Technology Demonstration (ACTD) program is developing advanced simulation technologies that provide a seamless synthetic battlespace to support joint training and mission rehearsal activities. STOW applied high fidelity, entity based simulation technologies across the full spectrum of conflict enabling evolutionary changes in how joint forces train and rehearse for operational missions. The ultimate goal is to develop mature simulation technologies capable of representing Joint Forces from the level of Operations Other Than War (OOTW) up to the Major Regional Contingency level of combat. Specific technology efforts being undertaken as part of STOW include 1) Large scale simulation system interfaces to real world C4I systems; 2) Advanced Distributed Networking; 3) Instantiation of DoD's High Level Architecture (HLA) within the actual simulation; 4) Advanced simulation forces and environmental models and; 5) Interoperability with the United Kingdom Synthetic Environment Program. These technologies are then transitioned to service and joint simulation developers, e.g. JSIMS.

(U) The STOW ACTD is comprised of Synthetic Environment, Synthetic Forces, Systems Design and Integration and, Advanced Network components. The Synthetic Environment component concentrates on the creation of large scale digital environments including representation of dynamic terrain and targets, weather and environmental phenomena, as well as seasonal and diurnal variations. The Synthetic Forces component creates a scaleable, computer-generated joint military force that is both representative and behaviorally credible. This entity based simulation includes models of command nodes as well as various intelligence sensors and their related platforms. The high fidelity of the computer generated forces provides the capability to resolve battle outcomes at the weapon system level of detail.

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The system Design and Integration component develops the overall DoD High Level Architecture (HLA) compliant system design, interfaces to C4I systems, distributed exercise management, data collection and, after action reviewed technologies. This architecture supports the capability to initialize, manage, and analyze large scale distributed joint and combined exercises. The Advanced Networks component develops and tests Networking technologies necessary to support large scale distributed exercises. DARPA will transition products, documentation and lessons learned to the Defense Information System Agency (DISA) to facilitate the efficient and cost effective utilization of evolving network infrastructures.

(U) The STOW prototype will support the United States Atlantic Command (USACOM) JTF level exercise, Unified Endeavor in October 1997, as well as, subsequent USACOM exercises during FY 1998 and FY 1999. Operational experience in these large scale joint exercises provides valuable lessons learned, documentation and technology products to support the emerging family of Joint Simulation systems, e.g. JSIMS, WARSIM, NASM, JSIMS Maritime component.

(U) The Operational Simulation Technology Program has been divided into two programs. The Advanced Simulation Technology Thrust (ASTT) builds on the STOW Program and develops advanced simulation technology supporting the next generation of DoD simulation systems. The goal of the ASTT program is to extend core simulation technology research such as advanced synthetic environments modeling, multi-resolution modeling, and scaling. The ASTT program will act as a bridge to future DoD simulation developments such as the Joint Simulation System (JSIMS). The other element of the OPSIM program will integrate Advanced Distributed simulation and ASTT developed technologies into operational planning systems to provide course of action analysis.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Accomplishments:

- Developed an interactive synthetic terrain database which supports an environmentally robust joint battlespace. This includes the continued development of environmental technologies such as interactive terrain and hydrology, battlefield obscurant and diurnal effects. Developed technology for simulating the full range of dynamic terrain effects, e.g. cratering, damaged buildings, fighting positions, etc. ($6.0M)
- Developed and transitioned a broad range of synthetic forces representing combat elements integrated with the DoD HLA a distributed command and control structure from all of the services. Integrated a distributed command and control structure portraying, in simulation, the influence of one command level on the actions

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of subordinate synthetic units. Continued to re-architect synthetic forces to a HLA compliant design. ($15.0M)

- Demonstrated the prototype Synthetic Theater of War simulation supporting a seamless land/sea/air warfighting synthetic environment capable of representing a Joint Task Force (US-UK). Integrated and tested expanded HLA compliant network technologies and network security devices. Integrated initial versions of the DMSO-DARPA Run-Time Infrastructure. Developed and integrated simulation interfaces to real world C4I systems. Developed and integrated a HLA compliant data collection and analysis component to support After Action Reviews. Designed and tested an advanced ATM based wide area networks to support large scale joint exercises. Began the transition of STOW technologies, documentation and lessons learned to emerging joint and service managed simulation programs, e.g. JSIMS, WARSIM and other service simulations. ($15.0M)
- Developed advanced simulation technologies, beyond the scope of the STOW ACTD, supporting next generation simulation systems (e.g. JSIMS, WARSIMS, et.al.). Technology efforts include: Multi-fidelity synthetic environments and multi-resolution modeling of synthetic forces, adaptive behaviors and rapid behavior development for synthetic forces, scaleability to 20K platform objects in real time, improved synthetic environments network performance, and data collection techniques for use in a multi-cast environment. ($4.6M)
- Developed and demonstrated a prototype integrated simulation capability, to support rapid course-of-action analysis for a single service planning system, using automated, faster than real time (FTRT) battle simulation, with both friendly forces and reactive OPFOR to enable rapid review of courses of action developed as part of mission planning. ($1.9M)

(U) <u>FY 1998 Program</u>:

- Based on lessons learned from Unified Endeavor 98-1 and USACOM operational requirements, continue to improve upon the STOW prototype to provide demonstrations of an increased operational capability to the joint warfighter. This includes enhancing the warfighter's capabilities to employ high fidelity, platform level simulations for increased readiness. Integrate new/improved synthetic environments, synthetic forces, and networking technologies as well as products developed through the United Kingdom's Synthetic Environment program. Integrate ASTT technologies as appropriate while transitioning STOW technologies to JSIMS. ($13.5M)
- Continue to develop advanced simulation technologies to support JSIMS, WARSIM and other service simulations. Technology efforts include: Adaptive multi-skilled Synthetic Forces; Scaleability greater than 20,000 objects; distributed multi-cast data collection on large amounts on data; rapid generation of computer generated forces and alternative methods of SAF generation; single synthetic environments database

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abstraction to accommodate multiple simulation requirements; initial multi-resolution modeling techniques. ($13.0M)

- Continue to develop course of action analysis capability based on advanced simulation technologies. Expand analysis capability to multiple joint planning systems. ($2.0M)

(U) FY 1999 Program:

- Continue to develop, demonstrate, and transition prototype technologies supporting a DoD High Level Simulation Architecture. Demonstrations will continue to focus on the representation of a seamless land/sea/air warfighting synthetic environment with an ever increasing degree of realism, supporting service and joint operational training and retaining the arbitration of battle outcomes at the platform level. ($13.8M)
- Continue to develop advanced simulation technologies to support JSIMS and WARSIM and other service simulations. Technology efforts include demonstration of: Scaleability to 100K objects in the simulation, goal based reasoning for synthetic command entities, advanced multi-resolution modeling techniques, and improved terrain data base correlations. Complete transition of all technologies to JSIMS, et al. ($12.9M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	47.3	33.5	21.7
Appropriated	N/A	39.6	N/A	N/A
Current Budget	N/A	42.5	28.5	26.7

(U) **Change Summary Explanation**:

FY 1997 Reflects repricing of elements of the STOW ACTD.
FY 1998-99 Reflects rephasing of $5M in ASTT funding from FY 1998 to FY 1999 to better fit development schedule requirements.

(U) **Other Program Funding Summary Cost**: N/A

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(U) **Schedule Profile**:

Plan	Milestones
Oct 97	United Endeavor 98-1, demonstrate STOW's ability to support technically and operationally significant joint and combined operations.
Oct 97	Demonstrate a major application of the DoD High Level Architecture.
Mar 98	Demonstrate the ability of Command Forces to plan a course of action, replan/respond to unexpected OPFOR tactics.
Sep 98	Demonstrate ability for ADS network to support real-time transport of a .3 Gigabyte at 3k transactions per second.
Sep 98	Continue to support USACOM training objectives in future United Endeavor Exercises.
Oct 98	Demonstrate STOW's ability to support significant mission rehearsal and crisis response operations. Integrate and evaluate technologies developed under the United Kingdom's Synthetic Environments program. Utilize the STOW prototype to support the operational evaluation of technologies developed under the ASTT and JSIMS program.
Sep 99	Complete the development, integration and documentation of the STOW prototype transitioning all to JSIMS.
Sep 99	Transition ADS simulation technologies to the JSIMS and the service simulation developments.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Global Grid Communications CST-02	(41,957*)	52,190	44,566	43,916	44,750	49,549	54,549	49,549	Continuing	Continuing

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies, PE 0603226E (Project EE-45).

(U) **Mission Description:** This project develops and demonstrates advanced networking technologies needed for global defense operations in the 21st century. Network services will be developed in order to support geographically dispersed staff for crisis management and to support warfighters in rapid deployment, highly mobile scenarios. The program will demonstrate that information technologies can be integrated with both advanced optical, high performance networks and mobile, wireless tactical. This will provide multimedia information flows, efficient use of bandwidth, and minimal logistical requirements for warfighting, disaster relief, emergency medical support. The program requires the design, adaption and development of new internetwork protocols.

(U) The goals of the JTF-ATD include development of a rapid Commander Joint Task Force (CJTF) crisis response capability for a range of situations from multiple regional conflicts (MRCs) to operations other than war (OOTW) capable of being established and operational in days; provide collaborative planning tools to enable the development of integrated, executable operations plans in hours; provide enroute planning and execution management for the JTF staff; provide a software reference architecture that provides access to the defense information infrastructure (DII), links the national command authority (NCA), commander in chief (CINC), JTF and the components, and enables rapid tailoring of the operational environment; provide common servers and an application suite; migrate to the DII.

(U) The goal of a Warfighter's Internet is to expand open architecture and internetworking technologies into the mobile wireless domain to: provide a robust, automatically reconfigurable, internetworking capability; and, to support warfighters in rapid deployment and highly mobile scenarios. This will be accomplished through enabling a backbone communications network consisting of multiple airborne nodes which in turn connect to users and networks on the ground, on the ocean, and in the air. Provision for multimedia information flows, efficient use of bandwidth, and minimal logistical requirements are key objectives that require the design, adaptation and development of new network protocols for mobile, wireless battlefield networks. Technology development and demonstration will focus on networking technologies to integrate across existing and developmental communication systems and networks using airborne nodes such as Global Hawk (Airborne Communications Node). A scalable internet will be demonstrated in conjunction with joint service exercises and advanced warfighting experiments.

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(U) The Broadband Information Technology (BIT) program seeks to develop the all-optical multiple wavelength transmission and networking technologies. Specifically, this program has four goals: (1) a billion bit per second bandwidth on demand, independent of the analog and digital nature of the applications, (2) rapid, nearly transparent reconfiguration of network routing, (3) multiplexing of continuous transmission rates (bit rates from thousands of bit per second to billion of bits per second), and (4) transmission of analog and digital signals in a single fiber.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Identify control and protocol issues for operation of multi-wavelength networks. ($4.2M)
- Demonstrate advance integrated optoelectronic network component operations. ($9.3M)
- Complete multi-wavelength network architecture and control planning; and initiate field-trial network deployment for long-distance and wide area applications. ($14.5M)
- Demonstrate integration with advanced virtual testbeds, increase number of JTF ATD servers, tools and applications available to the warfighter, expand use of additional Object Oriented and advanced Web technologies, initiate development of scenario interpreters, multi-threaded services, bandwidth adaptive servers, and context based resource switching. ($16.4M)
- Demonstrate a disaster relief and emergency medical services system that will provide real-time multi-media patient data (vital signs, EKG. images) from an accident scene and from enroute vehicles to Emergency Department physicians. Demonstrate enhanced command and control of emergency medical responders by providing real time location of assets and by providing best routing algorithms for quickest path to and from the accident scene. ($7.8M)

(U) FY 1998 Program:

- Demonstrate multi-wavelength network management and control in local area testbeds. ($7.5M)
- Demonstrate 40 billion bit per second cross-connect switching and 32 channel transceiver chip. ($10.3M)
- Continue analysis and report on economics of multi-wavelength network architecture and technology for local area optical networks. ($4.6M)
- Continue integration with advanced virtual testbeds and design and conduct assessments of information services needed to extend the Joint Task Force (JTF) Infrastructure from the planning phase into the execution dynamic replanning phase. Develop Java-compatible Object Web Tools for generic plan editing, and

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demonstrate persistent brief development tools, bandwidth adaptive object based distribution and sharing, and schema unified semantic interoperability of several applications. ($14.2M)

- Initiate and complete design and development of first phase of mobile, wireless network software and protocols, network management, security, application interfaces, and RF subsystem integration and engineering for a joint Service study to define technical requirements and network systems architecture for a Warfighter's Internet/joint tactical internetwork. ($8.0M)

(U) FY 1999 Program:

- Demonstrate full operations, multi-wavelength, experimental, system network including interoperability among testbeds distributed across several geographic domains. ($14.9M)
- Develop software applications and servers, and expand the JTF reference architecture to include execution and dynamic replanning. Implement self test and remote test and maintenance mechanisms, demonstrate intel anchor desk, real time execution using multi-threaded servers and bandwidth adaptive applications, compact plan visualization of hypothetical future outcomes, and rapid set up tools and techniques for planners forecasting. Demonstrate rapid development of specialized plan viewers for multiple echelons. Develop distributed information logistics services of optimization of time-value of information delivery. ($14.0M)
- Validate airborne, wireless backbone using manned aircraft/airborne platform; continue to develop network protocols and integrate into commercial products; integrate legacy and emerging radios in mobile, wireless internet. ($15.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	42.0	48.4	33.9
Appropriated	N/A	49.0	N/A	N/A
Current Budget	N/A	52.2	44.6	43.9

(U) **Change Summary Explanation**:

FY 1997 Increase reflects repricing of the demonstrations portion of the JTF ATD.
FY 1998-99 Changes reflect realignment of program priorities to initiate the Tactical Warfighter Internet Program.

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(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Planned	Milestones
2Q FY97	Demonstrate feasibility of high data rate wireless connectivity between Marine Enhanced Combat Operations Center and forward deployed observer teams.
3Q FY97	Demonstrate integration with advanced optical testbeds. Conduct large scale planning demonstrations.
4Q FY97	Complete first phase of deployable JTF C3 development (mobile C3, plan rehearsal and refinement during deployment, intelligent interfaces).
3Q FY98	Complete large-area demonstration of optical network and advanced network management.
4Q FY98	Demonstrate initial execution and dynamic replanning functionality.
4Q FY98	Complete first phase of the design and development of components for the mobile wireless network.
3Q FY99	Complete second phase of joint tactical internetwork, network hardware and software demonstrated on multiple airborne and terrestrial platforms.
3Q FY99	Demonstrate 20 gigabit per second, multi-channel, multi-media, large-area network.
4Q FY99	Demonstrate advanced execution and dynamic replanning functionality.
4Q FY99	Field demonstration of Warfighter's Internet end to end architecture coordinated with BADD, Extended Littoral Battlespace (ELB) and Small Unit Operations advanced warfighting experiments.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Defense Simulation Internet (DSI) CST-03	(24,705*)	32,342	2,880	1,500	1,500	1,500	0	0	0	N/A

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies, PE 0603226E (Project EE-46).

(U) **Mission Description:** The goal of the Defense Simulation Internet (DSI) program is to research, develop and test at scale (worldwide), a network infrastructure capable of enabling distributed, real-time, multi-media (video, voice, shared data and work spaces) simulation that will seamlessly integrate all simulation, modeling, command and control functions from early design to battle rehearsal enroute to the conflict. The DSI meets DoD security requirements by using a commercial-off-the-shelf (COTS) encryption device (INES). The communications needs of the distributed, real-time, multi-media modeling and simulation community cannot be met with any other available technology. Commercial vendors are pursuing some of the required technologies, but development is too slow and unfocused to accommodate the immediacy of the Department of Defense's simulation requirements. The DSI program provides focus for the commercial development of the technologies needed by the simulation community for distributed work environments worldwide. Over 100 nodes currently extend the DSI to each of the Services, most of the Commanders-in-Chief (CINCs), some of our allies and other Government affiliated sites. These locations constitute the network's user sites; they provide valuable feedback on the technologies and methodologies being pursued and critical capability for both ongoing and major modeling and simulation events. A key mission of the DSI is to provide real time infrastructure for the Synthetic Theater of War (STOW) 97.

(U) The DSI will transition to the Defense Information Systems Agency (DISA) Defense Information Systems Network (DISN) by the end of FY 1997 and be operated on a reimbursable basis. It will be jointly managed by DISA and DARPA through the Advanced Information Technology Systems Joint Program Office. The transition of the DSI into the DISN provides affordability through consolidation of the costs required to operate multiple networks while continuing to support modeling and simulation requirements.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Communication and Simulation Technology, PE 0603761E, Project CST-03

(U) FY 1997 Program:

- Provide network operations and user services. As a subnet of DISN, it is expected that by the end of FY 1997 the subnet work will contain an estimated 30% more user sites. Operations include the 24 hours per day/7 days per week, network security, exercise/event planning, management and the 24 hours per day/7 days per week CSC Help Desk. Provide STOW Exercise support. ($9.0M)
- Procure telecommunication circuits: International circuits (T3 backbone), CONUS Phase II Backbone (T3) Tail Circuits (T1), upgrade high use STOW sites to high capacity tail circuits. ($10.3M)
- Upgrade network: Complete deployment of service upgrade which provides ATM switches, end-to-end encryption and the edge devices to sites which require this upgraded capability (70 Sites). Automate network management to provide real-time management of high speed high bandwidth requirements. Provide resource reservation at the application level. Complete migration of Defense Simulation Internet (DSI) network operations and maintenance to Defense Information Systems Network (DISN). ($10.5M)
- Transition management: Provide programmatic integration management and engineering support through the DARPA/DISA (Advanced Information Technology Systems (AITS)) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($2.5M)

(U) FY 1998 Program:

- Transition management: Provide programmatic integration management and engineering support through the ARPA/DISA Advanced Information Technology Systems (AITS) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($2.9M)

(U) FY 1999 Program:

- Transition management: Provide programmatic integration management and engineering support through the ARPA/DISA Advanced Information Technology Systems (AITS) Joint Program Office (ADJPO) to identify and evaluate advanced technology candidates, offer pilot services, and transition LES technology to DISA. ($1.5M)

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RDT&E, Defensewide BA 3 Advanced Technology Development	Communication and Simulation Technology, PE 0603761E, Project CST-03

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	39.7	3.0	0
Appropriated	N/A	38.9	N/A	N/A
Current Budget	N/A	32.3	2.9	1.5

(U) **Change Summary Explanation**:

FY 1997 Decreases reflect repricing of network operations and telecommunications circuits.
FY 1998 Decrease reflects minor repricing.
FY 1999 Increase reflects a requirement for on-going management and engineering support for the AIST Joint Program Office.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 97	Fully integrate an automated network and life cycle management.
Apr 97	Initiate Service Migration to DISA.
Sep 97	Complete network services transition to DISA.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Sensor and Guidance Technology,
PE 0603762E, R-1 #57

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Sensor and Guidance Technology	**0**	**108,360**	**166,855**	**200,582**	**188,512**	**190,487**	**205,487**	**234,287**	**Continuing**	**Continuing**
Guidance Technology SGT-01	0	11,294	32,661	36,600	29,212	28,000	34,200	52,000	Continuing	Continuing
Aerospace Surveillance Technology SGT-02	0	1,471	33,500	58,000	71,000	53,000	36,000	47,000	Continuing	Continuing
Air Defense Initiative SGT-03	0	20,970	18,100	29,000	27,000	23,000	25,000	25,000	Continuing	Continuing
Sensors & Exploitation Systems SGT-04	0	74,625	82,594	76,982	61,300	86,487	110,287	110,287	Continuing	Continuing

(U) **Mission Description:** The Sensors and Guidance Technology program element is budgeted in the Advanced Technology Development Budget Activity because it is developing the system oriented technologies to enhance sensor and weapon system accuracy and capability to meet current and emerging threats. Four projects are funded in this program element: Guidance Technology, Aerospace Surveillance Technology, the Air Defense Initiative, and Sensors and Exploitation Systems.

(U) The Guidance Technology project is leveraging geolocation technologies to enhance the navigation and/or guidance packages of airborne platforms, ground vehicles and weapons. These improved systems will improve the accuracy and effectiveness of stand-off weapons, minimizing collateral damage while reducing the cost-per-kill.

(U) Aerospace Surveillance Technologies programs are developing technologies to improve the accuracy and timeliness of surveillance systems in all weather, in hostile reception environments, and when necessary, in a covert manner. The five programs funded by this project exploit recent advances in multispectral target phenomenology, signal processing, high performance computing and micro-electronics technologies.

(U) The Air Defense Initiative is an on-going activity whose overall goal is to reduce the proliferating cruise missile threat and enhance the survivability of U.S. assets in the face of enemy electronic countermeasures.

(U) The objective of the Sensor and Exploitation Systems project is to provide the warrior with situational awareness and battlefield dominance by developing key sensor technologies; providing near-real-time exploitation of imagery data; and semi-automated target recognition and tracking.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Sensor and Guidance Technology, PE 0603762E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Guidance Technology SGT-01	(11,876)*	11,294	32,661	36,600	29,212	28,000	34,200	52,000	Continuing	Continuing

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies PE--0603226E.

(U) **Mission Description:** Fire-and-forget stand-off weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively with minimal collateral damage, and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geolocate targets accurately in the same coordinate system (i.e. WGS-84) in which the weapon system navigates; (2) the surveillance, targeting and weapon systems have precision navigation and guidance systems on-board; and (3) navigation and target location systems operate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. The achievement of these characteristics in an integrated system is the goal of this program. The Global Positioning System (GPS) Guidance Package (GGP) technologies are applicable for both new or retrofit guidance/navigation packages for a variety of airborne platforms, ground vehicles, surface-to-surface standoff weapons and air-to-surface weapons. Additional thrusts are included in this project to increase the robustness of precision GPS navigation; to increase the versatility of navigation systems applications by developing micro-electromechanical sensor inertial navigation system technologies; and to apply the geolocation technologies/techniques to precision threat geolocation (Advanced Tactical Targeting Technology Program).

(U) GGP tightly integrates a miniature GPS receiver and an all solid state, low cost, navigation-grade, interferometric fiber optic gyroscope (IFOG) based miniature inertial measurement unit (MIMU) with an advanced navigation computer into a low cost ($15,000), precision navigation system. GGP Phase I addressed the technology issues involved in: (1) miniaturizing navigation grade inertial measurement units (IMUs) into a compact, manufacturable configuration; and (2) developing a multi-channel-on-chip, high dynamics GPS receiver. A Memorandum of Agreement (MOA) has been signed and implemented to demonstrate a Phase 1 unit on an Army Fire Support Team Vehicle (FIST-V). Successful demonstrations were conducted at Redstone Arsenal in June 1995 using a M981 FIST-V. Successful demonstrations also were conducted on an F/A-18. These tests assessed the performance of tightly coupled systems in high dynamics and validated Phase 1 design scenarios. GGP Phase 2 requirements place more stressing demands on performance of MIMU components and call for further reductions in size, power and weight. An MOA has been signed with the Navy designating GGP Phase 2 as the Navy's Advanced Integrated Navigation and Control Package. Another MOA was signed with the Program Executive Officer, Tactical Missiles, Army Missile Command. Potential applications

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include the Multiple Launch Rocket System. A third Memorandum of Agreement (MOA) is in coordination with the Program Executive Office, Ground Combat and Support Systems, Army Tank and Automotive Command. Potential application is the Bradley Fire Support Team Vehicle (FIST-V).

(U) The Global Positioning Experiments (GPX) will increase the robustness of GPS receivers by increasing their ability to operate effectively in presence of enemy jamming or countermeasures. First, an all-in-view Miniature GPS Receiver (MGR) chipset will be upgraded to demonstrate direct precision GPS code acquisition by employing a fast acquisition correlator engine and high performance clock. Operation with precision P(Y) GPS code signals increases the MGRs robustness to jamming. The second thrust will provide for the design, development, implementation and demonstration of a low cost, all digitally controlled GPS adaptive phased array receiver antenna; coherent precision matched analog antenna components; and antenna recalibration for stressing military environments.

(U) The Micro-Electromechanical Sensor Inertial Navigation System (MEMS INS) program will improve the silicon based, inertial sensors (gyros and accelerometers) developed in the MEMS technology program and integrate them with navigation software into a low power, small, light weight, low cost, tactical grade (0.1 degree per hr to 10 degrees per hr drift rate) INS. In addition to more portable applications, the MEMS INS will be generic for insertion/imbedding into other military systems. MEMS INS Phase 1 will perform the following: (1) select and improve appropriate MEMS inertial sensors, (2) select and refine foundries/foundry processes, (3) design the mechanical subsystem, and (4) select/refine the navigation software and perform INS simulations of the modeled sensors. Phase 2 will develop the MEMS inertial sensors brassboard, integrate them into a MEMS INS and demonstrate the brassboard in the field.

(U) The Advanced Tactical Targeting Technology (AT3) will demonstrate a passive tactical targeting system for the lethal suppression of enemy air defenses (SEAD). The SEAD mission must now be accomplished in the face of new electronic order of battle (EOCB) and new engagement tactics by enemy air defenders such as frequent threat emitter shutdowns. Today's targeting systems fail to provide timely information to target the growing mobile threat. Far more comprehensive, near real time, cockpit battlefield awareness must be provided. This includes synchronization of multi-platform information, long range emitter identification and target geolocation within seconds. An order of magnitude improvement in rapid target geolocation accuracy is needed against mobile surface to air missiles. Emerging DARPA technologies can combine to provide an affordable lethal SEAD tactical targeting capability. These include leveraging the GPS Guidance Package and clock technologies for precision time and location. Low cost, light weight RF wideband digital receiver, processor and adaptive antenna functions can be implemented in advanced technology multichip modules. The Advanced Tactical Targeting Technology (AT3) objectives are to develop passive

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targeting technologies with precision time standards, wideband low cost multichip module based radio frequency (RF) receivers and threat association algorithms and to demonstrate an affordable tactical targeting system solution. Two airborne architectures will be considered. One will employ AT3 systems on an opportunistically diverse mix of platforms netted together by communications links. The other will employ a single strike aircraft with two or more dedicated miniature air-launched radar decoys, each carrying an AT3 and communication system.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:
- Complete GGP Phase 2 designs and begin fabrication of two competitive GGP units. ($10.1M)
- Complete evaluation of Phase 1 units on the Navy testbed aircraft. ($.2M)
- Investigate and evaluate applications of the Miniature GPS Receiver (MGR) portion of the GGP for enemy air defense suppression. ($1.0M)

(U) FY 1998 Program:
- Continue fabrication and begin integration of GGP Phase 2 hardware and software. ($10.0M)
- Design circuits and power management techniques for the direct precision GPS code, low power, robust MGR. ($5.1M)
- Design the GPS adaptive antenna array, signal processing and control functions for the MGR. ($4.1M)
- Identify micro-electromechanical sensor (MEMS) foundries and develop MEMS inertial navigation architecture(s). ($5.0M)
- Initiate Advanced Tactical Targeting Technology (AT3) design and development. ($8.5M)

(U) FY 1999 Program:
- Perform final integration and testing of GGP units; deliver eight units. ($4.6M)
- Fabricate and demonstrate the robust MGR. ($5.0M)
- Conduct final design reviews and complete integration of adaptive GPS receiver antenna and signal processing. ($6.0M)
- Iterate MEMS foundry inertial sensor fabrication and initiate preliminary sensor testing. ($9.0M)
- Complete AT3 design and conduct critical component demonstrations. ($6.8M)
- Begin AT3 brassboard fabrication. ($5.2M)

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Sensor and Guidance Technology,
PE 0603762E, Project SGT-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	10.5	15.0	16.6
Appropriated	N/A	10.3	N/A	N/A
Current Budget	N/A	11.3	32.7	36.6

(U) **Change Summary Explanation**:

FY 1997 Increase reflects minor repricing and GGP studies efforts.
FY 1998-99 Increase reflects additional efforts for more robust Miniature GPS Receiver (MGR) guidance, micro-electromechanical sensor (MEMS) inertial navigation technologies and the Advanced Tactical Targeting Technology Program.

(U) **Other Program Funding Summary Cost**:

	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003
PE 0305154D	N/A	1.1	0	0	0	0	0	0
PE 0305206D	N/A	N/A	2.8	3.0	3.0	2.0	2.0	1.0

(U) **Schedule Profile**:

Plan	Milestones
Jun 97	Conduct GGP Phase 2 critical design review.
Jul 97	Begin fabrication of GGP Phase 2 units.
Feb 98	Begin design of the Advanced Tactical Targeting Technology (AT3).
Jan 98	Complete systems requirement reviews for adaptive GPS antenna array.
Jul 98	Conduct Preliminary Design Review for MEMS inertial navigation system.
Aug 98	Complete preliminary design of the AT3.
Sep 98	Begin integration of hardware and software for GGP Phase 2 units.
Oct 98	Complete design and begin fabrication of the direct P(Y) code, low power MGR.

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Oct 98	Complete critical design reviews and begin fabrication of an adaptive GPS antenna array.
Dec 98	Evaluate brassboard micro-electromechanical (MEMS) in testbed.
May 99	Complete AT3 critical component demonstrations and begin brassboard fabrication.
Jun 99	Deliver GGP units to the Government.
Sep 99	Complete integration of an adaptive GPS antenna array.
Sep 99	Evaluate Brassboard MEMS sensors in testbed.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Aerospace Surveillance Technologies SGT-02	(3,000)*	1,471	33,500	58,000	71,000	53,000	36,000	47,000	Continuing	Continuing

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies PE 0603226E.

(U) **Mission Description:** This project funds space and airborne sensor efforts whose purpose is to improve the accuracy and timeliness of our surveillance systems for improved battlefield awareness. Timely surveillance of enemy territory under all weather conditions is critical to providing our forces with the tactical information needed to succeed in future wars. This operational surveillance capability must perform during enemy efforts to deny and deceive the sensor systems, and operate, at times, in a covert manner. This project will exploit recent advances in multispectral target phenomenology, signal processing, large constellation satellite architectures, low-power high-performance computing, and low-cost micro-electronics to develop advanced surveillance systems.

(U) The Eclipse program will develop the concept to deny imagery from advanced enemy sensors. The performance of this function is strongly driven by resolution and obscuration. This concept would be to adversely deny the enemy battlefield situational awareness and limit his capability for the detection, classification and identification of ground-based objects.

(U) The Passive Millimeter Wave (PMMW) Imaging System Program will develop and demonstrate a passive, "all weather" imaging capability for the covert detection and classification of military targets. Aperture sizes to be developed will be an order of magnitude larger than current generation PMMW systems to obtain resolutions ranging from 3 meters to less than 1 meter from tactical UAV operational altitudes. This program will pursue system designs that exploit MIMIC technology to manufacture large numbers of mm-wave components affordably, sparse aperture system concepts that greatly reduce hardware complexity, and recent advances in low power high performance computing. Military applications will be selected and demonstrated based upon deficiencies characteristic of current generation imaging systems - both active and passive.

(U) The Passive Radar Tag for Covert Communications will provide a covert capability to remotely extract data from unattended ground sensors and Special Operation Forces (SOF) in real-time by airborne sensors such as the Joint Surveillance Target Attack Radar (JSTARS) or Advanced Synthetic Aperture Radar System (ASARS) surveillance radar systems. Miniature prototypes have been developed for other radars such as the APS-137 and APS-145 used on the E-2C

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and P-3. The tags will use special wake-up circuitry, surface acoustic wave delay lines, and modulation techniques to detect, delay, and modify radar pulses from these radars such that the return pulse received by the radar will include unique identification numbers and data messages from the tag. Covertness will be obtained by the choice of modulation and the amplitude of the returned signal. The interrogating radars will be modified to detect, identify, and display the tag message. Variants of the tag will be produced to be compatible with air delivered internetted ground sensors and with man portable tags used by SOF units. Low cost tags (<$300) will be developed for cost effective and covert, friendly situation awareness. Other variants will be used to precisely register synthetic aperture radar imagery and to enhance communications of geolocation and other data between widely dispersed operating units.

(U) The Adaptive Spectral Reconnaissance Program will develop a new generation of airborne reconnaissance systems based on spectrally adaptive imaging sensors. Spectral technology will enhance the ability to conduct wide area search for high value targets from both manned and unmanned airborne platforms. This program will, with Defense Airborne Reconnaissance Office funding, develop a system using reflected sunlight. The DARPA funded effort will develop a thermal infrared version to provide day/night capability. This system will be demonstrated on an Unmanned Air Vehicle (UAV) platform.

(U) The Tactical Radar Program will develop technologies to meet the stressing needs associated with mobile target detection; i.e. one meter or better resolution with a revisit time of under fifteen minutes. This program will pursue innovative spacecraft and radar designs that minimize complexity and cost; e.g., by employing complex radar waveforms that address range ambiguities. Battlefield Visualization (BV) and geo-referenced Precision Guided Munitions (PGM) call for high-density, high-accuracy Digital Terrain Elevation Data (DTED). Affordable methods of obtaining this data from single and multiple satellites will also be explored.

(U) The Novel Antennas Program will develop small lightweight sensor systems with low power requirements that will identify and locate emitters in dense environments. The program will leverage a number of technologies including photonics, antennas, adaptive arrays, superconductivity and digital receivers and will directly attack the stressing problems of co-channel interference and multipath. The system will offer the user community significant capability gain over existing and planned systems. The program will involve close and continuing cooperation with prospective user agencies.

(U) The Large Millimeter Wave Telescope (LMT) is a Congressionally mandated program to develop the largest (50 meter aperture) fully steerable millimeter wave radio telescope built to date. The design features a sophisticated

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laser metrology system to maintain precise alignment of the optics, and real time closed loop adaptive control actuator system to maintain a near-perfect parabolic surface at all pointing angles and under most environmental conditions.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Completed the design of the foundation, pedestal, pedestal bearing, radome and tilting structrures and the mechanical drive and pointing systems of the Large Millimeter Wave Telescope program. ($1.5M)

(U) FY 1998 Program:

- Eclipse program - Perform concept and feasibility analyses to deny imagery from advanced optical sensors. ($1.0M)
- Passive Millimeter Wave (PMMW) Imaging program - Initiate and complete concepts of operation studies for employment of system for the detection and classification of military targets. Initiate and finalize configuration definition for the detection system using MIMIC technology and innovative system design concepts to satisfy user-defined military applications. Initiate fabrication of detection system and configuration definition for the very large aperture classification system. ($6.0M)
- Passive Radio Frequency (RF) Tags for the Covert Communications program - Perform concept analyses for multiple concepts of operation to include remote communications of sensor data from unattended ground sensors, data communications from Special Operations Forces (SOF), geo-registration of Synthetic Aperture Radar (SAR)/Moving Target Indicator (MTI) imagery, and communications of geo-location and other data between dispersed operating units. System design for each operational concept will be conducted, and fabrication of brass board RF tags, modifications to airborne SAR/MIT processors and ground stations will be completed. ($7.5M)
- Adaptive Spectral Reconnaissance program - Begin development of a Long Wavelength Infra-red (LWIR) hyperspectral cueing sensor for UAV application. The phenomenology will be established to support the use of this system. These sensors will include both the hardware and software necessary for integration as an airborne wide area surveillance system. ($4.0M)
- Tactical Radar Program - Initiate concept designs. Develop and mature critical technology areas to include orbital configurations that when combined with innovative system concepts, can provide the required coverage

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frequency and ground resolution, complex radar waveforms that will address range ambiguities, and innovative system designs that minimize cost by reducing spacecraft complexity. ($7.0M)

- The Novel Antennas Program - Develop antenna elements, photonic links and algorithms for sensor systems for identifying and locating emitters; undertake data collection for use in system design and testing; carry out systems studies and preliminary performance tests, including a non-real time demonstration of a ground based system. ($8.0M)

(U) FY 1999 Program:

- Passive Millimeter Wave (PMMW) Imaging program - Finalize configuration definition and initiate development for the classification system. Final designs and sub-scale ground demonstrations will be completed for the detection system. ($8.0M)
- Passive Radio Frequency (RF) Tags for the Covert Communications program - Test multiple brass board RF Tags and the modified airborne Synthetic Aperture Radar (SAR) and Moving Target Indicator (MTI) radar systems. Ground and flight tests with several airborne platforms will be performed to validate performance. Design and fabrication of miniaturized tags will be performed and a test and evaluation plan developed. ($7.0M)
- Adaptive Spectral Reconnaissance program - Begin fabrication of LWIR spectral queuing sensor. Preliminary work will be done for the integration of this sensor into a wide area surveillance system. Data will be collected to support the development of software. ($4.0M)
- Tactical Radar program - Complete concept designs. Complete development and maturation of critical technology areas. Initiate design and fabrication of concept demonstration program. Perform tests of new SAR waveforms and techniques using existing airborne SAR platform. ($22.0M)
- The Novel Antennas Program - Complete development and selection of antenna elements, photonic links and algorithms for sensor systems for identifying and locating emitters, and accomplish a proof-of-concept demonstration. ($17.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	0	0	0
Appropriated	N/A	1.5	N/A	N/A
Current Budget	N/A	1.5	33.5	58.0

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(U) **Change Summary Explanation**:

FY 1998-99 Funding increases reflect initiation of the Eclipse program, Passive RF Tags effort, Tactical Radar program, Adaptive Spectral Reconnaisance effort, and Novel Antennas program.

(U) **Other Program Funding Summary Cost**: *(In Millions)*

Passive Radar Tags

Source	FY 1996	FY 1997	FY 1998	FY 1999
DARO	0.5	1.0	1.0	-

Adaptive Spectral Reconnaissance

Source	FY 1996	FY 1997	FY 1998	FY 1999
DARO	0.0	4.0	4.0	4.0

(U) **Schedule Profile**:

Plan	Milestones
Eclipse Program:	
Feb 98	Start concept development.
Aug 98	Complete studies.
Passive Millimeter Wave Imaging System:	
Feb 98	Defined Detection System ConOp.
May 98	Defined Classification System CONOP.
Aug 98	Preliminary Design Review (Detection System).
Jan 99	Critical Design Review (Detection System).
Mar 99	Preliminary Design Review (Classification System).
May 99	Sub-Scale Ground Test (Detection System).
Aug 99	Critical Design Review (Classification System).
Oct 99	Full scale Ground Test (Detection System).

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Radar Tags:
Jan 98 Concept Analysis.
May 98 System Design.
Sep 98 Fabricate brass board RF Tags.
Sep 98 Modify airborne Synthetic Aperture Radar (SAR) processors and ground stations.
Nov 98 Test brass board Radio Frequency (RF) Tags.
Nov 98 Test airborne SAR processors and ground stations.
Jan 99 Performance flight test RF Tags to verify system operation.
Sep 99 Fabricate miniaturized RF Tags.
Sep 99 Develop system test plan.

Adaptive Spectral Reconnaissance:
Nov 98 Release solicitation for Phase I contracts.
Jun 98 Award of contracts.
Sep 98 Preliminary Design Review for both systems.
May 99 Critical Design Review for Phase I efforts.
May 99 Integration begins.
Sep 99 Subsystems ready for test.

Tactical Radar:
Jan 97 Complete system level trades analysis.
Apr 97 Users requirements definition.
Jun 97 System performance specification/risk reduction analysis.
Nov 98 Start development of less than mature critical technology areas.
Jun 99 Complete concept designs.
Novel Antennas:
Jan 98 Perform preliminary performance testing.
Sep 98 Perform non-real time demonstration.
Aug 99 Conduct proof-of-concept demonstration.

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Large Millimeter Wave Telescope:

Nov 96 Preliminary design review complete.

Mar 97 Site selection complete.

May 97 Conduct critical design review.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Sensor & Guidance Technology, PE 0603762E

COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
SGT-03 Air Defense Initiative	(23,545*)	20,970	18,100	29,000	27,000	23,000	25,000	25,000	Continuing	Continuing

* PE 0603226E, projects EE-CLS and EE-41 previously funded these efforts.

(U) **Mission Description:** This Project encompasses several advanced technologies related to the development of techniques to counter advanced battlefield threats. These programs include the Novel Antenna Program, the Low-Cost Cruise Missile Defense (LCCMD) Program, the Synthetic Aperture Radar Electronic Counter-Countermeasures (SAR ECCM) Program, The Mountain Top Program, the Air-Defense Simulation Program and the Advanced Signal Processing (ASP) Program.

(U) The SAR ECCM Program will develop techniques to make U.S. Synthetic Aperture Radar (SAR) systems less vulnerable to intentional enemy jamming or deception. SAR systems have become one of the most widely used broad area surveillance systems. They are critically important to the development of battlespace awareness and their jamming and/or deception could seriously degrade U.S. warfighting capability. The SAR ECCM program will determine the military impact of various SAR jamming techniques and develop countermeasures against the highest priority threats.

(U) The DARPA Mountain Top Program provides a cost effective ground-based radar system for the advancement and evaluation of concepts and technologies required for future airborne surveillance radars. Through robust data collection and analysis campaigns, the Mountain Top Program identifies and quantifies natural and man-made phenomenology that may limit Airborne Early Warning (AEW) system performance. Central to this activity is the Radar Surveillance Technology Experimental Radar (RSTER), located at the Pacific Missile Range Facility (PMRF), Kauai, Hawaii. In FY 1996, the Mountain Top Project segregated the RSTER hardware program segment from the signal processing and analysis effort to form two distinct programs; Mountain Top and Advanced Signal Processing. The RSTER system continues to serve as the focal point for the Mountain Top Program and program activities continue to concentrate on joint testing and integration to effect a successful RSTER system transition to the Services, specifically, the Navy E-2 Program Office, PMA-231, by FY 1998.

(U) The DARPA Air-Defense Simulation (Transition Support) Program conducts integrated analysis, modeling, simulated exercise, and demonstration efforts to develop Advanced Air Combat Concepts (A2C2) using DARPA technologies and to facilitate technology transition to the Services. Examples of these concepts include advanced fire control support for Air Force and Navy fighters as well as air directed surface-to-air missile (ADSAM) operations of Army and Navy systems. Analysis and modeling efforts will be performed to develop and refine employment architectures and concepts

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of operations (CONOPS) utilizing DARPA technologies. Primary vehicles for these efforts will be in-house analysis, contracted studies, support for the Joint Staff (J-8) led Joint Cruise Missile Defense (JCMD) Study, and seminar wargames used to create and assess robust warfighting concepts supported by DARPA technologies. Selected portions of warfighting concepts will be demonstrated using these tools to validate key capabilities of DARPA technologies. Field demonstration scenarios will be derived from the analysis and modeling effort, combined with simulated exercises to facilitate operator involvement early in the process. CMD study plans call for DARPA to be a node on the Distributed Interactive Simulation (DIS) network with multiple Service Modeling and Simulation activities. Simulated exercises will concentrate on distributed interactive simulation (DIS) in addressing CONOPS and BM/C4I issues, while field demonstrations will highlight sensor operational effectiveness and treat transition-related factors in more depth.

(U) The Novel Antennas program will couple photonics, antennas and adaptive array processing experience with digital receiver and superconductivity to produce a small, light-weight, low-power system capable of locating specific emitters in a dense interference environment.

(U) The Low Cost Cruise Missile Defense (LCCMD): Program will employ emerging weapon system technologies to provide a cost effective approach to defeat a proliferated cruise missile threat. Weapon system options will be investigated, focusing on the development of a very low cost interceptor which could be deployed in large numbers.

(U) The emerging threat of cruise missiles imposes significant burdens on existing air defense sensors and systems. The current cruise missile defense effort is developing sensors which address engaging and destroying this difficult-to-detect, low flying threat which may be armed with weapons of mass destruction. Because of the potential payload, it is very desirable to be able to destroy the threat at long ranges (near its launch point). The use of airborne sensors will allow multiple ground-based missiles such as Patriot to engage the cruise missiles at ranges which are over the horizon to the Patriot ground-based radar. This concept is called ADSAM (Air Directed Surface to Air Missile). The purpose of this program is to demonstrate the architecture required for such remote engagements. It will build on the concepts explored in the DARPA Mountain Top with the Navy, which was completed in 1997 with the transition of the RSTER radar to the Navy under an MOU, and demonstrate the application of ADSAM to Army missiles. Patriot missiles will be modified under Army funding to permit successful engagement of low flying cruise missiles.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

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(U) FY 1997 Program:

- Novel Antennas: During FY 1997 DARPA will work closely with customers to complete the operational and system requirements study for the demonstration system. Risk reduction will occur on the antennas, photonics, and adaptive algorithms. Concept definition will be completed and initial subsystem capability demonstrated. ($.6M)
- Mountain Top Program: This program will finalize the Memorandum of Agreement between DARPA and the Navy and effect transfer of custody of the RSTER asset to the E-2C Program Office, PMA-231. ($5.0M)
- Simulation: This program will focus on the development planning for an F-16 Silent Fighter Demonstration, an demonstration of advanced sensor support for fighters, an Advanced Combat ID demonstration, and a Joint Strike Fighter (JSF) Architecture study. ($6.6M)
- Advanced Signal Processing: This program will employ the virtual STAP Algorithm Development Support Environment at MHPCC to design and develop advanced STAP algorithms for future AEW radar. The program will be completed in FY 1997 with the Simulation testing of fieldable radar processing STAP algorithms. ($8.8M)

(U) FY 1998 Program:

- LCCMD: The concept development efforts will be completed and a design effort will commence with the most promising concepts. All, part, or none of each of the concepts studied in the previous phase may be carried forth. ($8.8M)
- SAR(E)CCM: A study panel will complete their effort and algorithm/hardware implementation will commence. ($3.3M)
- ADSAM: The funds in this project will be used to provide cruise missile type targets, data links, test facilities, and the instrumentation required to evaluate the ADSAM architecture. Two series of tests, the first evaluating data link interfaces and checking out the instrumentation system, and the second evaluating the capabilities of the ADSAM architecture will be conducted. ($6.0M)

(U) FY 1999 Program:

- LCCMD: The design efforts begun in FY 1998 will be completed. Fabrication of test articles for the FY 2001 demonstration(s) will begin. The number of demonstrations will be determined by the number of design study contracts awarded in FY 1998. ($19.0M)
- SAR ECCM: Implementation of SAR ECCM algorithms and hardware will commence. Design efforts and test planning will get underway in preparation for a proof of principle demonstration scheduled for FY 2000. ($7.0M)

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- ADSAM: Analysis of data gathered during FY 1998 will be completed, and assets will be readied for transition to other cruise missile defense efforts. A final report discussing conclusions, effectiveness, and requirements will be prepared. ($3.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	21.8	18.6	20.5
Appropriated	N/A	21.4	N/A	N/A
Current Budget	N/A	21.0	18.1	29.0

(U) **Change Summary Explanation**:

FY 1997-98 Decrease reflects minor repricing.
FY 1999 Increase reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
LCCMD:	
Jan 98	Concept Downselect.
Sep 98	Concept SDR.
Mar 99	Concept PDR.
SAR(E) CCM:	
Oct 97	Study Panel Final Report.
Jan 98	Algorithm/Hardware Selection.
Mar 98	Algorithm/Hardware Implementation.

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MOUNTAIN TOP:
Sep 97 Completion of DARPA Mountain Top Program.

SIMULATION:
Apr 97 Joint System Integration Testing.
Jun 97 F-16 Field Demonstration.
Aug 97 Offboard Sensor Support Concept Demonstration.
Sep 97 Operator in the Loop Simulations.

ADVANCED SIGNAL PROCESSING:
Sep 97 Completion of program.

ADSAM
Sep 98 Interface and Data Link Evaluation.
Mar 98 ADSAM Architecture Demonstration.
Mar 99 ADSAM Demonstration.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Sensor and Guidance Technology, PE 0603762E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Sensor and Exploitation Systems SGT-04	(73,829)*	74,625	82,594	76,982	61,300	86,487	110,287	110,287	Continuing	Continuing

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies, PE 0603226E (Project EE-40).

(U) **Mission Description**: The development efforts described herein embody key sensor demonstrations and the exploitation of sensor products. These efforts, in conjunction with those described in Project CCC-02 (Information Integration Systems) seek to develop the systems needed to provide the warrior with situational awareness and battlefield dominance. The strategic goals of this project are to: develop key sensor technologies required to support dominant battlefield awareness including sensors which can counter Camouflage, Concealment and Deception (CC&D); provide near-real-time, semi-automatic, exploitation of wide-area moderate (and high) resolution imagery; and provide semi-automated recognition and birth-to-death tracking of high value units and critical moving targets. These goals are being addressed by the Counter CC&D Program, the Semi-Automated Imagery Intelligence (IMINT) Processing (SAIP) Advanced Concept Technology Demonstration (ACTD), Moving and Stationary Target Acquisition and Recognition (MSTAR), Moving Target Exploitation (MTE), and Automatic Target Recognition (ATR) applications programs.

(U) The goal of the Counter CC&D Program is to provide significant enhancement of the military's capability to detect obscured targets hidden under natural and artificial camouflage. Specific goals include validation of Foliage Penetration (FOPEN) target detection capability (0.1 FA/sq.km max) with data from the P-3 Ultra-Wideband UHF Synthetic Aperture Radar (SAR) testbed and the DARPA-sponsored Swedish Carabas I Very High Frequency (VHF) SAR tests; and demonstrations of real-time processing of FOPEN high resolution SAR image formation, Radio-Frequency Interference (RFI) suppression and Automatic Target Detection/Classification (ATD/C) algorithms. A FOPEN Airborne Demonstration Radar will be developed for demonstration on a manned platform providing inputs via narrowband tactical data links for ground image exploitation. The image exploitation processing of SAIP will be extended for FOPEN as well as Multi/Hyper Spectral Image (M/HSI) sensor input, geolocation and sensor fusion processing of images, and detection of time critical targets. The program will ultimately combine FOPEN Radar on an Endurance Unmanned Aerial Vehicle (UAV) with other airborne sensors (e.g., the Senior Year Electro-optical Reconnaissance System on the U-2, and develop combined exploitation technologies for insertion into the DARO Common Imagery Ground/Surface System (CIGSS).

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(U) The Semi-Automated IMINT Processing (SAIP) ACTD will develop, test and transition to the operational user, automated algorithms and semi-automated tools that enhance the warfighter's capability to: process SAR, and later EO imagery; conduct wide-area search for Ground Order of Battle and Missile Order of Battle targets; perform rapid site modeling and site monitoring; and produce target reports in near real-time (< five minutes). Goals for the baseline system are: automatic target cueing and classification for a limited set of vehicles (10 targets); object level change detection; force recognition to the company level; and interactive target recognition and terrain delimitation. Goals for an enhanced system are: Increasing the automatic target cueing and classification to 20 targets; site modeling and monitoring with EO; and addition of SIGINT cueing. Goals for an enhanced fielded system are to increase automatic target recognition to 30 targets.

(U) The goal of the Moving and Stationary Target Acquisition and Recognition (MSTAR) program is to achieve a major advance in SAR Automatic Target Recognition (ATR) performance through fundamental and innovative technology developments and to transition this technology to fielded systems with ATR requirements. Other program goals include: Significant advances in interactive image exploitation environments and performance; development of rapid target model construction and rapid ATR updating methods; development of resource management systems for surveillance and exploitation, and development and demonstration of ATR and compression-based techniques to reduce communication bandwidths for SAR-based wide area search platforms to SATCOM-supportable bandwidths. Two approaches are being investigated and evaluated: A single scale approach that combines existing SAR image formation processing with detection and compression algorithms; and a multi-scale approach that embeds detection within the image formation processing to greatly reduce implementation complexity. Specific applications are targeted for the U-2 AIP and Global Hawk platforms although other reconnaissance and surveillance platforms that disseminate SAR imagery could also benefit from Intelligent Bandwidth Compression (IBC) technology.

(U) The goal of the Moving Target Exploitation (MTE) program is to achieve a major advance in computer-assisted moving target identification by providing previously unavailable capabilities to automatically detect, track, and classify high-valued ground-moving targets using all-weather airborne surveillance radar data. Four techniques are being investigated and evaluated: the automatic tracking of ground moving vehicles; the automatic analysis of moving vehicle motion patterns and behavior patterns to identify purposeful military movement; the discrimination of desired targets from other moving vehicles using high range resolution (HRR) moving target indication (MTI) range profiling and 1-D automatic target recognition (ATR); and the imaging of specific moving targets via enhanced moving target imaging (MTIm) processing and using 2-D ATR. Specific applications are targeted for the Joint STARS, U-2, and Global Hawk platforms.

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(U) The goal of the Congressionally-mandated Geographic Synthetic Aperture Radar (GeoSAR) Program is to develop and test an airborne, radar-based foliage penetration/terrain feature mapping and geographic information system with an emphasis on both defense and civil applications. The GeoSAR system will be comprised of a P-Band FOPEN/IFSAR for mapping beneath the tree canopy and an X-Band IFSAR open terrain mapping system, combined with an efficient Geographic Information System (GIS) ground processor.

(U) The goal of the Low-Cost Hypersonic Interceptor (LCHI) program is to cooperatively employ US and Russian expertise and low-cost approaches to develop and demonstrate a low-cost, ground-launched, hypersonic interceptor airframe. The airframe will be designed with an agreed-upon payload section interface, allowing potential users to employ their own application-specific warhead and guidance and control subsystems. The program will develop a cooperative agreement with Russia.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Complete Foliage Penetration (FOPEN) Concept Development and verify the System Requirements for a FOPEN Airborne Demonstrator radar targeted for a Medium or High Altitude Endurance (MAE/HAE) Unmanned Aerial Vehicle. Complete critical technology demonstration of ultra-wideband antenna design, airborne real-time processing interface, radio-frequency interference suppression, and FOPEN automatic target detection/classification. Develop and prototype Image Exploitation algorithms for FOPEN and EO (MSI) sensors within the SAIP exploitation architecture. Develop a test and evaluation plan with measurement criteria, validation approach and risk assessment matrix by critical technologies to integrate with the DUSD(AT) proposed Counter CC&D ACTD. ($14.6M)
- Transition of component modules into the SAIP ACTD will be completed and integration continued to achieve enhanced system objectives in continued collaboration with the Defense Airborne Reconnaissance Office (DARO). The site modeling and monitoring component will be integrated, additional Missile Order of Battle and Ground Order of Battle models and algorithms inserted, and the system ported to a High Performance Computer architecture. Tests will be done on system performance with ETRAC and national imagery. ($25.9M)
- The MSTAR 10 target recognition system with limited extended operating condition (EOC) capability will be integrated and evaluated, then matured into a 15 target system with increased EOC capability. Transition to SAIP ACTD of MSTAR modules will occur. Concepts and prototypes for interactive exploitation, rapid target

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insertion and rapid ATR updating will be developed and evaluated. The FY 1997 Intelligent Bandwith Compression (IBC) program will evaluate a single scale ATR-based bandwidth compression system in a laboratory environment and will demonstrate its operation in a laboratory configuration of mobile stretch (MOBSTR) and also with the SAIP SAR exploitation system. A multi-scale IBC architecture will be developed and demonstrated in a laboratory environment. Both single and multiple scale approaches will be evaluated for real-time hardware and software integration onto the U2-AIP and Global Hawk platforms. ($15.4M)

- The FY 1997 Moving Target Exploitation (MTE) program will complete the integration and evaluation of MTE target classification technology components in a ground-based component testbed; non-real-time moving target classification (HRR, MTIm, 1-D and 2-D ATR techniques) using recorded data will be demonstrated. Vehicle motion pattern analysis and behavior pattern analysis (MPA/BPA) techniques will be investigated and developed to identify purposeful military movement in MTI data. A simulation test bed will be developed to investigate, evaluate, and demonstrate enhanced ground tracking capabilities and preliminary techniques for MPA/BPA using scalable scenarios. The MTE program, in coordination with USAF ESC/JS, will record MTE data using the Joint Surveillance, Target, and Attack Radar System (Joint STARS) in FY 1997 and this data will be processed in the ground-based testbed. System analysis and trade studies will be conducted to an architecture to transition MTE technologies to the U-2 AIP and Global Hawk platforms. ($6.0M)
- Complete ground test demonstration of the GeoSAR P-Band radar, system integration in test aircraft, and critical design review of P-Band and X-Band radar. ($12.7M)

(U) <u>FY 1998 Program</u>:

- The counter CC&D Program will develop a Foliage Penetration (FOPEN) Airborne Demonstrator radar for test and evaluation on a manned platform, providing inputs via narrowband tactical data links to the image exploitation capabilities in SAIP ground processing facility. The Image Exploitation techniques developed under SAIP will be extended to include unique characteristics of VHF/UHF band FOPEN radar, high spatial resolution U2 SYERS MSI sensor, and high spectral resolution Predator HSI sensor, and multisensor correlation to improve the reliability of detection and discrimination of tactical targets under camouflage and foliage cover. ($24.0M)
- Semi-Automated IMINT Processing (SAIP) integration and field testing will continue to achieve transition system objectives and to support U-2 ASARS-2, and the ASARS Improvement Program. Transition to the operational customer, U.S. Atlantic Command, will begin. ($24.4M)
- The MSTAR 15 target recognition system with increased EOC capability will be integrated and evaluated, then matured into a 20 target system with greater EOC capability. The system then will be fully characterized vs. the defined target set and full EOC dimensions. Transition of the MSTAR system to SAIP and Counter CC&D

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ACTDs will occur. Full prototypes for interactive exploitation for two analyst missions will be developed and evaluated. A rapid target insertion prototype system will be built and evaluated, creating 5 target models and rapid ATR training systems as a baseline. A resource management prototype will be built and evaluated. The IBC program will combine the best performance components of the single scale and multiple-scale approaches and develop an integrated, real-time demonstrations for the U2-AIP or Global Hawk platform and in support of SAIP exploitation system split-based operation. Airborne and field demonstrations are planned. ($18.9M)

- The MTE program will demonstrate, near-real-time operational MTE performance against high-value moving targets by integrating the classification component and simulation testbeds developed in FY 1997 into a single MTE system testbed. This testbed will be exercised with recorded Joint STARS data. In parallel, more extensive MPA/BPA tools will be investigated, developed, and exercised and evaluated in the simulation testbed. The simulation testbed will be expanded to emulate the MTE data that will be available from the U2-AIP and Global Hawk platforms. The moving target classification (HRR, MTIm, 1-D and 2-D ATR) techniques will be evaluated and demonstrated for U2-AIP and Global Hawk sensor parameters. A coordinated Joint STARS and U-2/Global Hawk platforms will be conducted providing instrumented multiple platform MTI data. ($14.3M)
- The Low-Cost Hypersonic Interceptor (LCHI) program will establish the US and Russia teams, initiate joint concept development and requirements definition for the demonstration guidance and control section of the interceptor, and begin further definition and execution of critical experiments. ($1.0M)

(U) <u>FY 1999 Program</u>:

- The counter CC&D Program will complete Airborne Demonstrator Flight Test and Evaluation on manned platform in conjunction with SAIP ground exploitation capabilities during tactically significant military exercises to verify performance capabilities of ATD/C of tactical targets in CC&D. Initiate integration of FOPEN and Hyperspectral sensors into a Medium or High altitude/endurance (HAE) UAV depending on suitability of sensor and UAV CONOPS. ($25.0M)
- The ACOM Operational Assessment, with final transition configuration of system stood up, will be performed and demonstration of all software upgrades and transition will be conducted. ($9.5M)
- The evaluation of the MSTAR 20 target/full EOC system will be completed, system technology will be transferred to the SAIP and STARLOS programs, and a two year effort to develop a high performance computing adaptation for an MSTAR real time demonstration system will begin. Development and evaluation of resource management, rapid target insertion, rapid ATR updating and interactive exploitation systems will continue, with key milestones occurring in FY 2000. ($22.5M)

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- The MTE program will demonstrate MTE on-board the Joint STARS platform and will also demonstrate multiple platform MTE processing in a ground-based laboratory environment. ($5.0M)
- The LCHI program will complete definition of the demonstration interceptor, complete the critical experiments, and begin the detailed design of the airframe. ($15.0M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	69.2	83.2	85.5
Appropriated	0	75.7	N/A	N/A
Current Budget	0	74.6	82.6	77.0

(U) **Change Summary Explanation**:

FY 1997 Reflects minor repricing and program rephasing.
FY 1998 Reflects minor repricing offset by inclusion of the LCHI Program.
FY 1999 Reflects minor repricing and program rephasing.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
Mar 97	Engineering evaluation of Baseline SAIP configuration at Task Force XXI.
Apr 97	JSTARS data collection and system demonstration (MTE).
May 97	FOPEN Airborne Demonstrator Requirements Decision.
Jun 97	Demonstrate required MTE performance in JSTARS virtual testbed.
Jun 97	Demonstrate MTE tracking and target classification in a Joint STARS tape input, ground-based Phase I testbed.
Aug 97	Demonstrate multi-scale capability of data compression in lab environment.
Aug 97	Demonstration of FOPEN VHF/UHF Antenna technology.
Aug 97	LCHI US/Russia cooperative agreement signed.

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Sep 97	SAIP operational user evaluation at TBD exercise.
Nov 97	SAIP split-based CONUS configuration complete.
Nov 97	Second major demonstration of MSTAR ATR: 15 targets with increased EOCs. Transition modules to SAIP.
Jan 98	Laboratory Demo of FOPEN and HSI/MSI Image Exploitation on SAIP Architecture processors.
Jan 98	Airborne demo of data compression/screening capability on U-2R.
Jun 98	Operational demo of MTE system on JSTARS.
Jun 98	Real-time operational MTE demonstration with Joint STARS.
Jun 98	LCHI procurement and joint US/Russian team finalized.
Aug 98	Demonstrate required MTE performance in U-2 virtual testbed.
Nov 98	Start Integration of FOPEN Airborne Demonstration Radar.
Nov 98	Final MSTAR ATR demo: 20 targets, full range of EOCs; transition system to SAIP.
Nov 98	Joint operational demonstration with Joint STARS.
Jan 99	Ground demonstration of Image Exploitation of SYERS MSI and Predator HIS images.
Feb 99	Operational demonstration of MTE with the U-2.
Apr 99	Operational demonstration of MTE with an HAE.
Jun 99	Flight demonstration of FOPEN Radar with CIGSS Image Exploitation System.
Jun 99	Concept and requirements for LCHI demonstration interceptor finalized.
Jun 99	LCHI critical experiments for interceptor redesign complete.
Jul 99	Complete integration of SAIP transition configuration.
Sep 99	HAE demonstration (MTE).

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Marine Technology,
PE 0603763E, R-1 #58

COST (In Thousands)	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Marine Technology	**0**	**40,976**	**69,143**	**88,788**	**99,478**	**91,696**	**69,696**	**79,696**	**Continuing**	**Continuing**
Arsenal Ship MRN-01	0	19,577	47,200	50,000	36,000	22,000	0	0	0	N/A
Advanced Ship/Sensor Systems MRN-02	0	21,399	21,943	38,788	63,478	69,696	69,696	79,696	Continuing	Continuing

(U) **Mission Description**: The Marine Technology program element is budgeted in the Advanced Technology Development Budget Activity because it is developing and applying the technologies necessary to ensure U.S. maritime superiority. Two projects are funded under this program element: The Arsenal Ship; and Advanced Ship/Sensor Systems.

(U) The Arsenal Ship effort is leveraging DARPA technological advances in ship systems automation, surveillance, fire control and low observability, and employing acquisition streamlining techniques to develop an affordable and effective surface ship to provide land-based or littoral warfare support. A joint Navy/DARPA program, the Arsenal Ship will have approximately 500 Vertical Launch System cells, will require a very small crew (and possibly be unmanned), and incorporate survivability features in its basic design. The joint program will culminate in the construction of an Arsenal Ship demonstrator vessel.

(U) The Advanced Ship/Sensors Systems project is developing the systems and components necessary to engage and counter increasingly sophisticated submarine and underwater mine threats. Programs under development include sensor and sonar technologies, advanced ship mechanical systems, and advanced maritime platforms.

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RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Marine Technology, PE 0603763E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Arsenal Ship MRN-01	0	19,577	47,200	50,000	36,000	22,000	0	0	0	N/A

(U) **Mission Description:** In the Arsenal Ship project, DARPA will identify and develop high leverage technologies and acquisition improvements to support future surface ships with an emphasis on littoral missions. The objectives of this new project have far-reaching implications for the future of surface ships for the US Navy. The project is currently structured in two parts:

(U) Arsenal Ship is a high priority joint Navy/DARPA program to acquire a new capability for delivery of large quantities of ordnance (approximately 500 Vertical Launch System (VLS) cells) in support of land and littoral engagements. Key to both arsenal ship's affordability and operational flexibility is off-board integration of all but the most rudimentary C4I. The ships are to be theater assets that will operate under the authority of the joint Commanders-In-Chief (CINC's) and will receive their targeting along with command and decision information from other assets. Early in arsenal ship's life this control will be exercised through an Aegis platform, though as other assets mature, control will transition to aircraft such as AWACS or an E-2 with Cooperative Engagement Capability (CEC) and eventually to the Marine or Army shooter on the ground. Thus, the Arsenal Ship will not be fitted with long range surveillance or fire control sensors, but will be remotely controlled via robust data links. The data links will be secure, redundant and anti-jam in order to provide high reliability in the connectivity of the Arsenal Ships in high jamming operational scenarios. The overall program is an attempt to leverage the significant joint investment in Link 16 and CEC. The Arsenal Ship's survivability will be primarily achieved through passive design techniques. While active systems are not ruled out, they must be consistent with overall cost and manning goals. These design goals will allow the Arsenal Ship to have a very small crew (potentially, none at all) which will be a key ingredient in minimizing its life cycle costs.

(U) This demonstration program is a non-ACAT (Acquisition Category) program to design, construct, and test one arsenal ship demonstrator (ASD) to evaluate this new capability while minimizing the risks in acquisition of approximately six ships (to include conversion of the arsenal ship demonstrator to a fleet operational unit).

(U) As a result of studies that DARPA has performed, it is very clear that we should expect significant re-trenching from overseas deployments by US forces. This, coupled with the growing unaffordability of maritime pre-positioned logistics, will require that future forces be deployable from CONUS. The large travel distances suggest

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major payoffs for achieving speeds in excess of 50 or 60 knots and, in fact speeds of 75 knots or greater show major payoffs. We will explore the potential for sealift deliveries at speeds up to 100 knots to determine the breakpoints for cost and feasibility.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:
- Select three industry teams from Phase I arsenal ship concept studies to begin Phase II development of the functional baseline. ($18.6M)
- Perform initial evaluation of hydrodynamics for high speed regime. ($1.0M)

(U) FY 1998 Program:
- Complete arsenal ship Phase II functional designs by three industry teams and downselect to one team for detail design and construction of the arsenal ship demonstrator. ($47.2M)

(U) FY 1999 Program:
- Continue Phase III construction of arsenal ship demonstrator. ($50.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	16.4	65.0	40.0
Appropriated	N/A	16.0	N/A	N/A
Current Budget	N/A	19.6	47.2	50.0

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(U) **Change Summary Explanation**:

FY 1997 The $3.6 million increase reflects a below threshold reprogramming for the selection of three vice two industry teams for Phase II development of the functional baseline.

FY 1998-99 Change reflects realignment of funding profile to match the joint Navy/DARPA arsenal ship memorandum of agreement.

(U) **Other Program Funding Summary Cost**:

	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Navy Funding PE 0604310N	3.9	24.0	103.0	139.5	79.7	11.3	0.0	0.0	0.0	361.4

(U) **Schedule Profile**:

Plan	Milestones
Jan 97	Award three industry teams Phase II arsenal ship contracts.
Jun 97	Complete initial 100 knot speed feasibility evaluation.
Jan 98	Award one industry team Phase III contract to start Arsenal Ship Demonstrator (ASD) detail design/construction.
Feb 99	ASD keel laid.
Aug 00	ASD launched.
Oct 00	Begin ASD Demonstration/Testing Phase.

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COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Advanced Ship-Sensor Systems MRN-02	(24,239)	21,399	21,943	38,788	63,478	69,696	69,696	79,696	Continuing	Continuing

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies PE 0603226E.

(U) **Mission Description:** The objectives of this project are to develop and demonstrate advanced systems concepts and to pursue critical enabling technologies for maritime systems that will counter the threat created by the worldwide spread of increasingly sophisticated military technology. The evolving threat of quiet diesel/electric submarines, the proliferation of sophisticated submarine and weapons capabilities, and the growing stockpile of underwater mines available to third world countries necessitates the development of far-term solutions for increasing ship affordability and enhancing our operating capabilities in the littoral. This project will provide advanced technologies to enhance the capabilities of naval forces to more effectively operate "...forward from the sea" in a broader range of tactical environments.

(U) The Advanced Ship-Sensor Systems Program includes sensor and sonar technology, and advanced ship mechanical systems, and advanced maritime platforms. In the Sonar Technology area, applications of advanced object detection, classification, and localization technologies using High Performance Computing (HPC) are demonstrated. Active and passive sonar techniques are applied, using advanced sources and sonar systems built from distributed elements or concentrated arrays. Advanced signal processing techniques to integrate real-time information and background intelligence into the operational situation are included. These applications will result in enhanced Anti-Submarine Warfare (ASW) capability against diesel-electric submarines operating in shallow water.

(U) In the Advanced Ship Mechanical Systems area, technologies such as active structural controls, actuator and sensor systems and high speed digital signal processing are being developed. These technologies will result in reduced ship acoustic signatures, high performance/high reliability propulsion systems, a safer/more survivable ship, and increased ship system affordability.

(U) Advanced maritime platform efforts include technologies for innovative ships and ship systems to provide the multi-mission, sustained presence capability required for joint operations associated with future regional conflicts. The advanced ASW program addresses coordinated source and receiver concepts to substantially increase the range for reliable detection and classification of quiet submarines. A particular focus is waveform design for optimal noise rejection and enhancement of target echoes.

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(U) The Water Hammer program will design, fabricate, and demonstrate a mine neutralization system consisting of a phased array of shock tubes to generate, focus, and transport to militarily important distances (tens of meters) a pressure pulse of sufficient energy to neutralize the threat (≥1000 psi-msec; ≥2000 psi). Water Hammer has the potential for rapid, precision, in-stride lane clearance in deep or shallow water, reducing the need for high fidelity detection and classification. While the initial program focuses on mine/obstacle clearance, Water Hammer also has utility as a close-in defense system for ships against underwater threats. Current close-in defense systems are primarily surface based and address surface threats. Water Hammer can potentially provide rapid targeting and destruction of subsurface threats.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Complete final at-sea ASW demonstration of environmentally adaptive shallow water active sonar technology in conjunction with single/few platform scene generation capability. ($1.1M)
- Conduct tests to determine the effectiveness of supercavitating high speed bodies against fixed targets. ($.8M)
- Complete development of autonomous ASW multi-target detection technology. ($.8M)
- Fabricate and integrate a prototype active transmission vibration isolation mount. ($3.0M)
- Continue experimental program for EMTC technology to address electrode/magnet design, controller design, system optimization and power scaling issues. ($2.0M)
- Initiate development of the Netted Search, Acquisition and Targeting (NSAT) for littoral surveillance to include an acoustic source, as well as signal processing for enhanced detection and attack performance. ($4.0M)
- Design and initiate the fabrication of a prototype acoustic mine detection and classification system for a large (10 sqnm/hr) area coverage rate. ($1.6M)
- Develop space-time adaptive processing techniques and perform ocean tests to enhance long range active coherence and towed array detection performance. ($2.2M)
- The following Shallow Water ASW efforts were funded by Congressional additions to the FY 1997 President's Budget:

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- Extend autonomous ASW detection and classification effort to multiple targets and broader application to fleet systems. Deploy and evaluate autonomous submarine detection and classification processor in operational environment. ($2.8M)
- Develop advanced signal detection and processing algorithms to mitigate effects of torpedo acoustic countermeasures. ($1.2M)
- Design and develop a high-resolution synthetic aperture sonar towed-array system for mine detection and classification from high speed platforms. ($1.9M)

(U) FY 1998 Program:

- Continue development, plan, and test proof-of-concept Anti-Submarine Warfare (ASW) Netted Search, Acquisition and Targeting (NSAT) system at sea, incorporating a wide frequency band, autonomous, long duration, leave behind acoustic source; signal processing for enhanced detection and attack performance; and acoustic space-time adaptive processing. ($7.5M)
- Complete fabrication and conduct at-sea testing of a prototype acoustic mine detection and classification system for a large (10 sqnm/hr) area coverage rate. ($3.5M)
- Initiate development of a system for signal exploitation and environmentally adaptive waveform generation. ($6.0M)
- Develop advanced submarine hydrodynamics and structural designs that are focused toward reducing submarine target strength against active sensor detection. ($.5M)
- Initiate development of non-explosive underwater energy projection technology. ($2.0M)
- Commence design work for an at-sea demonstration of Electromagnetic Turbulence Control (EMTC) or other flow enhancements, exploiting potential drag reduction technologies leading to an improved flowfield for a submarine. ($2.4M)

(U) FY 1999 Program:

- Upgrade system and demonstrate detection-to-attack performance of a prototype ASW NSAT system, incorporating: full wide frequency band, autonomous, long duration, leave behind acoustic source, autonomous diesel electric detection; signal processing for enhanced attack performance; and acoustic space-time adaptive processing. ($12.1M)
- Upgrade system and conduct an at-sea demonstration test of a prototype acoustic mine detection and classification system for a large (10 sqnm/hr) area coverage rate. ($6.2M)
- Continue development of and conduct at-sea testing of a signal exploitation and environmentally adaptive waveform generation system. ($7.7M)

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- Continue non-explosive underwater energy projection technology development to include conceptual system design for a single shot device. ($4.9M)
- Continue development of advanced submarine hydrodynamics and structural designs that are focused toward reducing submarine target strength against active sensor detection. ($3.1M)
- Develop detailed design and test planning for the at-sea demonstration of Electromagnetic Turbulence Control (EMTC) or other flow enhancements in a large scale test vehicle. ($4.8M)

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	18.8	21.3	62.1
Appropriated	N/A	24.4	N/A	N/A
Current Budget	N/A	21.4	21.9	38.8

(U) **Change Summary Explanation**:

FY 1997 Decrease reflects repricing of the Acoustic Mine Detection system and the Vibration Isolation Mount effort.
FY 1998 Increase reflects minor repricing.
FY 1999 Decrease reflects realignment of program priorities.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**:

Plan	Milestones
3QFY97	Conduct functional demonstration of off-board detection and classification sensor.
3QFY97	Conduct laboratory demonstration of signal processing for enhanced detection and attack performance.
3QFY97	Complete development of coded waveform processing techniques and perform ocean tests to enhance long range active coherence and towed array detection performance.
3QFY97	Conduct feasibility test of countermeasure mitigation algorithms.
4QFY97	Complete prototype active transmission vibration isolation mount integration.

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4QFY97	Conduct laboratory test of power generation and conversion for an autonomous acoustic source.
4QFY97	Conduct design of acoustic mine detection and classification system.
4QFY97	Conduct at sea evaluation of autonomous submarine detection and classification processor in operational environment.
1QFY98	Complete airframe shake test of active transmission vibration isolation mount.
2QFY98	Conduct Anti-Submarine Warfare (ASW) Netted Search, Acquisition and Targeting (NSAT) system proof of concept test.
4QFY98	Conduct initial at-sea test of prototype acoustic mine detection and classification system.
4QFY98	Complete conceptual design development of single shot non-explosive underwater energy projection device.
4QFY99	Complete acoustic and shock tests of magneto-rheological fluid (MRF) mounts on Navy supplied large-scale testbed.
3QFY99	Conduct at-sea test of signal exploitation and environmentally adaptive waveform generation system.
4QFY99	Complete engineering system design of multipulse underwater energy projection array.
4QFY99	Conduct at-sea test of prototype NSAT.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Land Warfare Technology, PE 0603764E, R-1 #59

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Land Warfare Technology	**0**	**63,222**	**82,580**	**96,898**	**89,413**	**94,800**	**112,000**	**90,000**	**Continuing**	**Continuing**
Rapid Strike Force Technology LNW-01	0	19,920	29,000	38,500	18,000	17,000	24,000	20,000	Continuing	Continuing
Small Unit Operations LNW-02	0	43,302	53,580	58,398	71,413	77,800	88,000	70,000	Continuing	Continuing

(U) **Mission Description**: This program element is budgeted in the Advanced Technology Development Budget Activity because it is developing and demonstrating the concepts and technologies that will address the mission requirements of the 21st Century land warrior. Two broad efforts are being pursued in support of this objective: Rapid Strike Force Technology and Small Unit Operations.

(U) The Rapid Strike Force Technology project is developing the technologies necessary for highly mobile, covert transportation and information gathering systems to enhance U.S. early-entry capabilities. The primary thrusts of this project are the Combat Hybrid Power Systems program that is developing and demonstrating hybrid electric power and energy management systems for cavalry/scout vehicles; the Reconnaissance, Surveillance, and Targeting (RST) Vehicle program that is designing, developing and testing components and subsystems for a future lightweight, highly maneuverable manned or unmanned vehicle; and the Covert Subterranean Probe program that will enable accurate characterization of Deep Underground Facilities. Congressional fuel cell and helicopter active structural control initiatives are also funded in this project.

(U) The Small Unit Operations project is developing the critical technologies that will enable dispersed units to effectively perform warfighting operations that traditionally have required massed forces. Tactical level battlefield awareness, wireless communications, geolocation technologies for navigation in various terrains, internetted sensors, and automated tasking and control systems are but a few of the technologies being pursued in this project.

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COST *(In Millions)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Rapid Strike Force Technology LNW-01	0*	19,920	29,000	38,500	18,000	17,000	24,000	20,000	Continuing	Continuing

* In FY 1996, the Integrated Product and Process Development Program (Project EE-37, PE 0603226E) developed concurrent engineering/virtual prototyping technology that will be used in the conceptual design and analysis of the Combat Hybrid Power System.

(U) **Mission Description**: The emerging U.S. vision of future land warfare places strong emphasis on technology supporting early entry. This project is developing technologies that enable highly-mobile, covert transportation and information gathering systems, which are important aspects of an early-entry capability. The project consists of six primary efforts: Combat Hybrid Power Systems (CHPS); Molten Carbonate Fuel Cells; Helicopter Active Noise and Vibration Control (HANVC); Reconnaissance, Surveillance, and Targeting (RST) Vehicle; Covert Subterranean Probe; and Thermophotovoltaics (TPV). The CHPS and RST Vehicle programs are closely coordinated with the U.S. Army, Navy, Marine Corps, DARPA's Electric Vehicle Program (EV-01), and DARPA's Small Unit Operations Program (LNW-02).

(U) The Combat Hybrid Power System program will develop enabling technologies and conduct demonstrations of an integrated hybrid electric power system that provides power and energy management for all of the subsystems throughout the cavalry/scout vehicle and is scaleable to combat systems. The hybrid electric power system will consist of an engine/alternator, sized for average power demand, energy storage and power averaging components which provide both continuous and pulsed power, distribution networks, subsystem controls, and power conditioning devices. Vehicles will be simulated to evaluate subsystem requirements, topologies, and military utility. Hybrid electric power is an enabling technology for future combat vehicles if electrically powered subsystems are to be implemented. The vehicles will have greatly reduced noise and thermal signatures; and improved mobility, survivability, lethality, and fuel economy. By eliminating rigid connections between components, interior layout can be optimized, significantly reducing volumetric constraints. These advantages will result in deployable, affordable combat vehicles that meet mission requirements.

(U) The Carbonate Based Fuel Cells program will develop military enhancements to the Department of Energy's Direct Molten Carbonate Fuel Cell (MCFC) Program. The enhancements will assist in more rapid introduction of the MCFC power plants for stationary power applications for military bases by adding dual-fuel (natural gas and logistic fuel) and simulator capabilities. The MCFC power systems will provide a reliable and robust power for operations at overseas military sites using logistics fuel where natural gas may not be readily available.

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(U) The Helicopter Active Noise and Vibration Control (HANVC) program will design, fabricate and demonstrate an Active Rotor Control (ARC) system that should achieve 10dB radiated sound pressure noise reduction. This technology should significantly improve helicopter survivability by minimizing detection by helicopter mines and reducing alert time for shoulder launched missile crewmen. In addition, a system that actively cancels vibrations and noise from the main transmission will be demonstrated; this system has the potential for significantly reducing maintenance costs as well as crew and passenger discomfort.

(U) The Reconnaissance, Surveillance, and Targeting (RST) Vehicle program will design, develop, test, and transition to the Services critical components and technology for a lightweight, highly maneuverable vehicle. The vehicle will host integrated precision geolocation, communication and RST sensor subsystems provided by DARPA's Small Unit Operations Program. The RST vehicle will provide the essential mobility component of the DARPA, U.S. Army, and Marine Corps small unit operations concepts. Critical components and technologies include a high efficiency, reduced signature hybrid electric power system; an electric propulsion system; a semi-active electromechanical suspension to double cross-country speed and provide platform stabilization; an advanced survivability suite; and the capability to operate as either a manned or unmanned platform. The Marine Corps will develop vehicle concepts and chassis, integrate the DARPA developed components, and conduct vehicle performance tests (PE 0603640M). Additional co-funding for semi-autonomous capability will be provided by the Office of Secretary of Defense Joint Robotics Program (PE 0603709D).

(U) The Covert Subterranean Probe (CSP) Program will develop and demonstrate advanced technologies for the accurate characterization of Deep Underground Facilities (DUF) for precision strike or counterproliferation. CSP research will include: (1) Technologies for miniature (cm size) probes that can be introduced into known or suspected subterranean facilities to collect and record information about the facilities such as trace elements for indication of chemical, biological or nuclear weapons or materials; (2) Technologies to store and forward recorded information obtained by the covert probes and sensors, augmented by inertial navigation sensors to accurately trace the movement of sensor platforms; (3) Bistatic, remote sensing, and other technologies (electromagnetic and acoustic) for localizing and characterizing subterranean structures and the surrounding environment.

(U) The Thermophotovoltaics (TPV) program will develop and demonstrate thermophotovoltaic (TPV) technology and systems. TPV is expected to be the most efficient way to convert logistic fuel into electricity at power levels below 5 kW. TPV systems will be quiet, clean and reliable with low NOx <10ppm) emissions and few moving parts. A TPV system will supply better energy density than batteries for military portable and mobile power supply systems. The Services, especially the Army and Special Operations, face increasing demand for more energetic power sources for

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applications ranging from man-portable communication and electronics systems to the soldier system and pulse power. TPV can meet these demands in a compact, safe and reliable package.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- Combat Hybrid Power Systems (CHPS). ($10.6M)
  - Establish subsystem requirements, set component specifications, and provide modeling support to hybrid electric power system technology development.
  - Complete detailed design of hybrid electric power system demonstration.
  - Complete design and conduct proof of concept experiments of engine/alternator, power averaging, power conditioning, and power distribution and controller component options. Downselect for fabrication and demonstration.
- Carbonate Based Fuel Cells. ($2.4M)
  - Develop an operator training simulator, audio-visual simulator, and maintenance procedures for a dual-fuel MCFC power plant.
- Helicopter Active Noise and Vibration Control (HANVC) program. ($2.0M)
  - Demonstrate at Mach scale the Active Rotor Control (ARC) system.
- Thermophotovoltaics (TPV). ($4.9M)
  - Develop and demonstrate a TPV power system in the form of a BA-5590 battery but with three times the energy.
  - Demonstrate a portable TPV system in the field.

(U) FY 1998 Program:

- Combat Hybrid Power Systems (CHPS). ($20.0M)
  - Integrate simulation/modeling with laboratory demonstration hardware to provide hardware in the loop demonstration of virtual prototype.
  - Integrate hybrid electric power system subsystems for laboratory demonstration.
  - Complete technology development and fabrication of selected full-scale engine/alternator, power averaging, power conditioning, and power distribution and control components.

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- RST Vehicle. ($5.0M)
  - Design, develop, and test critical components for hybrid electric power system, mobility subsystems, and survivability suite.
- Covert Subterranean Probe. ($4.0M)
  - Initiate concept demonstration studies and development of component technologies.

(U) FY 1999 Program:

- Combat Hybrid Power Systems (CHPS). ($20.0M)
  - Complete development of critical enabling technology for high risk power system components.
  - Utilize hardware in the loop future scout vehicle virtual prototype to support technology development, and transition technology to USMC and U.S. Army Advanced Technology Demonstrators.
  - Test and evaluate hybrid electric power system in a laboratory demonstration.
- RST Vehicle. ($8.5M)
  - Fabricate and demonstrate critical RST vehicle subsystems including: Power system, propulsion, suspension, survivability, and controls.
- Covert Subterranean Probe (CSP). ($10.0M)
  - Develop common C3 Module for store and forward of information.
  - Initiate CSP system design and development.

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	0	15.0	20.0	20.0
Appropriated	N/A	19.0	N/A	N/A
Current Budget	0	19.9	29.0	38.5

(U) **Change Summary Explanation**:

FY 1997 Increase reflects repricing of the Combat Hybrid Power program.

FY 1998-99 Increase reflects introduction of the RST Vehicle and Covert Suppression Probe programs.

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(U) **Other Program Funding Summary Cost:** *(In Millions)*

		FY 1996	FY 1997	FY 1998	FY 1999
PE 0603640M	Marine Corps Advanced Technology	1.5	2.0	2.5	3.0
PE 0603709D	Joint Robotics Program	-	-	2.0	2.0

(U) **Schedule Profile:**

Plan	Milestones
Aug 97	Establish subsystem requirements, set component specifications, and support hybrid electric powersystem technology development using integrated, hybrid electric powered combat vehicle virtual prototypes.
Jan 98	Downselect components for final combat hybrid power system demonstration.
Mar 98	Complete Mission and Threat Analysis for Covert Subterranean Probe (CSP).
Apr 98	Complete a field demonstration of a portable Thermophotovoltaics (TPV) system.
May 98	Complete Mach-scale fabrication for Helicopter Active Noise and Vibration Control (HANVC) program.
Jun 98	Complete combat hybrid power system integration and test plan.
Aug 98	Complete wind tunnel tests of the Mach-scale active rotor system.
Sep 98	Test Reconnaissance, Surveillance, and Targeting (RST) vehicle critical components and conduct critical design review.
Sep 98	Complete design review of enabling technologies for CSP.
Oct 98	Complete simulators and procedures for dual-fuel MCFC power plant.
Jun 99	Demonstrate hardware in the loop virtual prototype of combat hybrid power system.
Sep 99	Demonstrate RST vehicle subsystems.
Dec 99	Initiate Probe Development.
Dec 99	Complete Covert Subterranean Probe (CSP) preliminary designs.
Mar 00	Integrate and demonstrate advanced components into combat hybrid power system laboratory demonstration.
Sep 00	Assemble subsystems and integrate into Marine Corps RST vehicle chassis.
Mar 01	Demonstrate 5-ton RST vehicle system capabilities.

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RDT&E, Defensewide BA 3 Advanced Technology Development	Land Warfare Technology, PE 0603764E

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Small Unit Operations LNW-02	(19,886)*	43,302	53,580	58,398	71,413	77,800	88,000	70,000	Continuing	Continuing

* The FY 1996 program was previously budgeted in the Experimental Evaluation of Major Innovative Technologies PE 0603226E. Related FY 1996 effort performed in PE 0602301E, project ST-11 ($3.5M) and PE 0602702E, project TT-04 ($10.8M).

(U) **Mission Description:** The objectives of this program are to develop critical technologies which enable dispersed units to effectively perform warfighting operations traditionally accomplished with massed forces. With declining resources and a smaller military, the Services must be prepared to quickly project sufficient power to achieve United States objectives rapidly and effectively. Due to the reduced forward presence of US forces, future deployment of our forces will be restricted by airlift assets and in-theater infrastructure; and they will operate under more complex rules of engagement. Adversaries who are not very powerful may possess sophisticated technology that will place our forces at risk. These risks are increased if our forces are massed to conduct traditional conventional operations. To fight effectively in the future, the Army and Marine Corps are developing concepts of operation (Army - Force XXI and Marine Corps - Sea Dragon) whose tactical implementation will vary, but with similarities that include lighter, more lethal, more flexible forces that are widely dispersed throughout the battlefield. The objective is to enable these forces to quickly control a large battlespace with dispersed forces, control the operational tempo, engage enemy targets with remote fire, and operate effectively across the spectrum of conflict and in a variety of environments.

(U) The keys to success for these units are a vastly improved and highly integrated comprehensive awareness system, robust communications, and an integrated, scaleable common grid of the battlespace. While there are many technology developments underway that will assist the Services to accomplish their objectives, at the tactical level there are technology gaps that DARPA will help narrow under the Small Unit Operations program. Technology development efforts will focus on a comprehensive awareness capability that provides real-time, essential information for small units and individual warfighters; wireless communication technologies to permit exchange of voice, digital and video data with other systems; geolocation technologies that provide navigation information in built-up, forested and mountain environments; internetted tactical surveillance and targeting sensors to complement information requirements not satisfied by national, theater, and component sensor programs; and automated tasking and control technologies for air and ground systems. As these technologies mature they will be tested and evaluated. Engineering demonstrations with combatant participation will be conducted to assess program progress in a realistic environment which provides

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critical user feedback. After successful tests and evaluation, or further refinement of the technologies, they will be integrated and tested with operational units.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:
- Assess advanced concepts and technologies for SUO applications. ($2.0M)
- Conduct field experiments and demonstrate SUO technologies at Commander in Chief (CINC) and Warfighter exercises. ($4.0M)
- Initiate developments for situation awareness and real-time tasking and control technologies focusing on tactical picture generation, tactical forecast, situation assessment functionality. ($5.4M)
- Initiate technology development for tactical communications capability. ($5.4M)
- Continue development of requisite technologies to provide precision geolocation. ($4.3M)
- Develop internetted remote control sensors to detect, localize and characterize targets. ($3.9M)
- Develop surveillance and targeting sensors systems for dispersed operations. ($4.7M)
- Evaluate tagging, robotics and on-demand imagery concepts. ($4.6M)
- Demonstrate sniper and mine detection technologies. ($3.6M)
- Develop Situation Awareness System architecture and initial design concept. ($5.4M)

(U) FY 1998 Program:
- Assess advanced concepts and technologies for SUO applications. ($2.2M)
- Conduct field experiments and demonstrate SUO technologies at CINC and Warfighter exercises. ($4.4M)
- Continue developments for situation awareness and tasking and control technologies focusing on plan generation and support asset tasking functionality. ($6.5M)
- Continue development for tactical communications capability. ($4.9M)
- Complete development and evaluation of requisite technologies to provide precision geolocation. ($3.0M)
- Continue development of internetted remote control sensors to detect, localize and characterize targets. ($4.7M)
- Continue development of surveillance and targeting sensors systems for dispersed operations. ($8.6M)
- Evaluate robotics and tactical deception concepts. ($7.4M)
- Develop and demonstrate Situation Awareness System detailed design. ($11.9M)

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Land Warfare Technology, PE 0603764E, Project LNW-02

(U) FY 1999 Program:

- Assess advanced concepts and technologies for SUO applications. ($2.6M)
- Conduct field experiments and demonstrate SUO technologies at CINC and Warfighter exercises. ($2.9M)
- Complete developments for the situation awareness and real time tasking and control technologies. ($1.6M)
- Complete technology development for tactical communications capability. ($2.0M)
- Complete development of internetted remote control sensors to detect, localize and characterize targets. ($4.0M)
- Complete development of surveillance and targeting sensors systems for dispersed operations. ($7.9M)
- Complete detailed design of Situation Awareness System. ($7.0M)
- Integrate and evaluate enabling technologies into Situation Awareness System. ($8.5M)
- Initiate development of brassboard Situation Awareness System. ($11.0M)
- Develop and integrate robotics capability into Small Unit Operations architecture. ($6.9M)
- Complete evaluation of tactical deception technologies. ($4.0M)

(U) **Program Change Summary:** (*In Millions*)

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	52.7	51.6	39.9
Appropriated	N/A	41.4	N/A	N/A
Current Budget	N/A	43.3	53.6	58.4

(U) **Change Summary Explanation:**

FY 1997-98 Increase reflects minor repricing.
FY 1999 Increase reflects increased program requirements.

(U) **Other Program Funding Summary Cost:** N/A

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(U) **Schedule Profile:**

Plan	Milestones
Mar 97	Complete Sea Dragon Communications and Coordination (SDC2) program and participate in Sea Dragon/Force XXI exercise.
May 97	Complete low power GPS test chips.
Sep 97	Complete sensor delivery vehicle wind tunnel test.
Oct 97	Complete prototype precision silicon clock.
Dec 97	Complete Situation Awareness System architecture.
Apr 98	Demonstrate brassboard communication technology.
May 98	Complete precision clock environmental and cell life testing.
Jun 98	Complete preliminary sensor delivery vehicle flight test.
Sep 98	Demonstrate and characterize various brassboard geolocation technologies.
Feb 99	Demonstrate sensors, tasking and control brassboard.
Jun 99	Demonstrate brassboard Situation Awareness System design.

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APPROPRIATION/BUDGET ACTIVITY
RDT&E, Defensewide
BA 3 Advanced Technology Development

R-1 ITEM NOMENCLATURE
Joint Strike Fighter Program,
PE 0603800E, R-1 #61

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Joint Strike Fighter Program JA-01	28,917	72,865	23,900	0	0	0	0	0	0	N/A

(U) **Mission Description**: The Joint Strike Fighter (JSF) Program is the focal point for defining affordable next generation strike aircraft weapon systems for the USN, USMC, USAF, and allies. Program emphasis is on facilitating the evolution of fully validated and affordable joint operational requirements, and demonstrating cost leveraging technologies and concepts to lower risk prior to entering engineering and manufacturing development (E&MD) of the JSF in FY 2001. The JSF Program is a joint program with no executive Service. Since FY 1995, the Navy and Air Force have provided approximately equal shares of annual program funding. DARPA's Advanced Short Take Off Vertical Landing (ASTOVL)/Conventional Take Off and Landing (CTOL) Common Affordable Lightweight Fighter (CALF) project (previously known as ASTOVL) was integrated with the JSF program by FY 1995 legislation. DARPA contributed funding for the JSF Program in FY 1996 under this new program element. The US/UK international collaborative CALF Program conceived by DARPA was investigating a revolutionary approach for melding advanced technology, multi-service commonality, and improved business practices into the demonstration of an affordable, capable replacement for the F-16, F/A-18, and AV-8B. DARPA has brought this insight and experience to bear in integrating the structure and philosophy of the CALF program within the JSF framework. DARPA is now serving as the Director for Joint Advanced Strike Technologies within the JSF program organization. This ensures that DARPA's expertise in advanced weapon system technologies, streamlined acquisition, and rapid prototyping are brought to bear in the JSF technology demonstration program.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments:
- Completed critical technology validation of the Direct Lift and Shaft Coupled Lift Fan Concepts. ($7.4M)
- Commenced Preliminary Demonstration Design Propulsion and JSF Competitive Engine efforts. ($18.3M)
- Commenced concept definition and design research for weapon system concept for a tri-service family of aircraft. ($3.2M)

(U) FY 1997 Program:
- Conduct ground demonstration of the concept demonstrator aircraft propulsion systems and technology maturation of the propulsion systems for the preferred weapon system concepts. ($43.2M)

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- Conduct alternate engine design and development. ($16.3M)
- Conduct concept demonstration program wind tunnel and propulsion test facilities support. ($13.4M)

(U) FY 1998 Program:

- Continue JSF Concept Demonstration Program including: Ground demonstrations, design and development of the concept demonstration aircraft, and concept refinement of the tri-service family of aircraft. ($23.9M)

(U) FY 1999 Program: N/A

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	30.7	78.4	23.9	0
Appropriated	29.9	76.9	N/A	N/A
Current Budget	28.9	72.9	23.9	0

(U) **Change Summary Explanation**:

FY 1996 Decrease reflects Bosnia reprogramming ($-.4 million) and transfer of funds to the SBIR PE ($-.6 million).

FY 1997 $4 million decrease reflects reprogramming to Arsenal Ship, PE 0603763E, Project MRN-01.

(U) **Other Program Funding Summary Cost**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
PE 0603800F	81.3	252.0	458.1	465.6	245.4	23.6
PE 0603800N	80.0	246.1	448.9	443.5	249.4	25.4
United Kingdom	14.0	71.0	55.0	34.0	6.0	0
Multilateral (Norway, Denmark and Netherlands)	0	8.3	9.6	7.6	5.0	1.7

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(U) Related RDT&E: PEs 0604800N & 0604800F: Milestone II for a joint follow-on engineering & manufacturing development (E&MD) program for the Joint Strike Fighter (JSF) is planned in FY 2001. The E&MD program will develop a tri-service family of aircraft from concepts proven under the JSF Program, incorporating affordable technologies transitioned from the JSF Program.

(U) **Schedule Profile**:

Plan	Milestones
Mar 96	Released request for proposals for Concept Demonstration Efforts.
May 96	Designated a joint, DOD, Acquisition Category 1D program by USD (A&T).
Nov 96	Competitively Awarded Concept Demonstration Contracts to Boeing and Lockheed Martin.
Mar 01	Complete milestone II for JSF Engineering Manufacturing Development.

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DATE February 1997

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 3 Advanced Technology Development	Dual Use Applications Program, PE 0603805E, R-1 #62

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Dual Use Applications Programs GC-01 / GC-02	0	181,184	225,000	225,000	225,000	225,000	225,000	225,000	Continuing	Continuing

(U) **Mission Description**: The mission of the Dual Use Applications Program (DUAP) is to prototype and demonstrate new approaches for leveraging commercial research, technology, products, and processes in military systems. In the long term, these new approaches to working with industry, many of which have been prototyped at DARPA, must become common throughout the DoD in order to take full advantage of the technological opportunities offered by the commercial sector. In particular, DUAP will enable the Services to leverage commercial R&D to improve the cost and performance of military systems, and to insert commercial products and processes into fielded systems to decrease operations and support (O&S) costs. Approximately $98 million of the FY 1997 funding was appropriated as one year funding, and these funds have been budgeted in a separate project to facilitate accounting oversight. The FY 1998 and subsequent year funds are all budgeted in a single project (GC-01).

(U) A Dual Use Steering Group, composed of the Under Secretary of Defense (Acquisition and Technology) USD(A&T), the Service Acquisition Executives (SAEs),the Deputy Under Secretary of Defense for International and Commercial Programs, and Director Defense Research and Engineering (DDR&E), is overseeing DUAP, which is administered by the Joint Dual Use Program Office (JDUPO). This "Board of Directors" will see that the approaches developed under DUAP transition throughout the DoD.

(U) Success depends on intentional leveraging of the commercial sector's research, products, and processes for the benefit of the DoD. By its nature, this is an entrepreneurial activity that pushes the envelope of the rules, regulations, and procedures typical in traditional DoD activities. While acquisition reform has helped clear the path, and experience has shown dual use R&D is practical, it has also shown that leveraging approaches are unfamiliar to many and have not yet been widely adopted. DoD's current challenge is to proliferate the use of commercial sector leverage more deeply throughout the Military Departments and establish it as a normal way of doing business.

(U) Beginning in FY 1997 the DUAP will fund two initiatives to encourage leveraging in the military Services. Roughly half will be spent on a dual use Science and Technology (S&T) Initiative that will be largely carried out by each Service. The remaining DUAP funds will be spent on the Commercial O&S Savings Initiative (COSSI), which will prototype an approach the Services could adopt to routinely insert commercial products and processes into fielded systems to reduce O&S costs.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 1997
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defensewide BA 3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Dual Use Applications Program, PE 0603805E, Projects GC-01/02

(U) Under both initiatives, proposals from industry will be identified and prioritized by the Services. In the S&T Initiative, each Service will generate its own BAA(s) and will evaluate, prioritize, and submit a list of projects for DUAP funding. Under COSSI, a BAA will be issued by JDUPO and the subsequent evaluation and prioritization will be done by each Service individually. The JDUPO will review the Service submissions and make recommendations on proposal selection to the Steering Group. Under both initiatives, final selections will be made by the Steering Group based on available funds.

(U) **Program Accomplishments and Plans**:

(U) FY 1996 Accomplishments: N/A

(U) FY 1997 Program:

- S&T Initiative: Each Service will generate a competitively selected, prioritized list of dual-use S&T projects for consideration by JDUPO -- i.e. projects to develop militarily useful, commercially viable technology. Each service will pick the technology areas they wish to emphasize. Included in the solicitation for each project will be a requirement for 50% cost sharing with industry. Additionally, each Service will be expected to contribute at least 25% of the total cost of each project; DUAP would provide the remaining 25%. The JDUPO will reconcile the recommendations of all three Services, and the Dual Use Steering Group will make the final selections. All projects will be awarded using either Cooperative Agreements or Other Transactions. This is essentially a "learning by doing" approach to dual use S&T in the Services, with DUAP funds providing an incentive and JDUPO providing advice across all the Services. ($81.2M)
- Commercial Operations and Support (O&S) Savings Initiative (COSSI): COSSI's mission is prototype an approach the Services could adopt to routinely insert commercial products and processes into fielded systems to reduce O&S costs by reducing the costs of parts and maintenance, reducing the need for specialized equipment, increasing reliability, and increasing the efficiency of subsystems. Selected proposers will develop, manufacture, and deliver prototype "kits" for installation into a fielded system. Each kit will consist of a commercial product or process that has been adapted, qualification-tested, and readied for insertion. Industry will work with Service program managers (i.e. the military customer) to develop their proposed technical approach and O&S savings analysis for the kits; proposals must include target prices for kits. In Stage I of each COSSI project, DUAP and the chosen proposer will share the costs of developing and testing the kit. In Stage II, provided Stage I has been successful, the military customer may purchase

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reasonable production quantities of the kits. It will be the goal to purchase the selected kits and, if applicable, maintenance agreements in Stage II:
- without recompetition,
- at a fair and reasonable price based on an analysis of the value of the kits to the Service (for O&S savings), and
- without requiring proposers to provide detailed cost and pricing data.

• To reduce the traditional administrative burden and oversight of government contracts and make COSSI more attractive to commercial firms, Stage I will be conducted using a section 845/804 prototyping agreement. ($100.0M)

(U) FY 1998 Program:
• S&T Initiative: In FY 1998, JDUPO's administrative role will be reduced in this portion of the DUAP. It is planned that JDUPO will participate in the process largely as a facilitator and trainer for the Services, providing DUAP funds to give incentive to the Services, and as consultant to the Military departments as they develop and institutionalize their own dual use procedures. ($100.0M)
• COSSI : In FY 1998 full responsibility for soliciting the COSSI projects will pass to the Services with the JDUPO filling a role similar to the one the played in the FY 1997 S&T initiative. ($125.0M)

(U) FY 1999 Program:
• S&T Initiative: In FY 1999 JDUPO will transition this portion of the DUAP to the Services. JDUPO's role will be exclusively monitoring ongoing efforts and advising the Military Departments on their own dual use procedures. ($100.0M)
• COSSI: JDUPO's role in FY 1999 will be one of advisor and facilitator as the Services establish their own version of the commercial insertion initiatives. ($125.0M)

(U) **Program Change Summary:** *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	N/A	250.0	195.0	195.0
Appropriated	N/A	181.2	N/A	N/A
Current Budget	N/A	181.2	225.0	225.0

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(U) **Change Summary Explanation**:

FY 1998-99 Increase maintains a level DUAP program to maximize service acceptance and adoption of DUAP acquisition techniques.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

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DATE February 1997

APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 6 RDT&E Management Support	Management Headquarters (R&D), PE 0605898E, R-1 #113

COST *(In Thousands)*	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	Cost to Complete	Total Cost
Management Headquarters MH-01	33,116	36,354	39,193	41,260	41,916	42,755	44,353	44,963	Continuing	Continuing

(U) **Mission Description:** This program element is budgeted in the Management Support Budget Activity because it provides funding for the administrative support costs of the Defense Advanced Research Projects Agency. The funds provide for personnel compensation for civilians as well as costs for building rent, physical and information security, travel, supplies and equipment, communications, printing and reproduction. In addition, funds are included for reimbursing the Military Services for administrative support costs associated with contracts undertaken on the Agency's behalf.

(U) **Program Accomplishments and Plans:**

(U) FY 1996 Accomplishments:

- Funding under this program element in FY 1996 supported management and administration for the RDT&E programs assigned to DARPA. The majority of the funds were required for the pay of personnel who operate the Agency. The funding level reflects the rental costs associated with the expansion of office space, and the related support and security requirements.

(U) FY 1997 Program:

- DARPA will continue the management and administrative support efforts for headquarters at approximately the same level as FY 1996 as well as enhanced physical and information security requirements. Increases reflect annualization of increased support begun in FY 1996.

(U) FY 1998 Program:

- DARPA will continue the management and administrative support efforts for headquarters at approximately the same levels as FY 1997. The funding level reflects increased rent, pay raise requirements, and a legislative initiative to expand Intergovernmental Personnel Act appointments.

(U) FY 1999 Program:

- DARPA will continue the management and administrative support efforts for headquarters at approximately the same levels as FY 1998. The funding level reflects pay raise requirements.

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APPROPRIATION/BUDGET ACTIVITY	R-1 ITEM NOMENCLATURE
RDT&E, Defensewide BA 6 RDT&E Management Support	Management Headquarters (R&D), PE 0605898E, Project MH-01

(U) **Program Change Summary**: *(In Millions)*

	FY 1996	FY 1997	FY 1998	FY 1999
President's Budget	32.6	36.4	37.3	38.5
Appropriated	32.6	33.8	N/A	N/A
Current Budget	33.1	36.4	39.2	41.3

(U) **Change Summary Explanation**:

FY 1996 Increase reflects minor repricing and enhanced security requirements.
FY 1997 Increase reflects fully funded program.
FY 1998-99 Increase reflects pay raises and legislative initiative to expand Intergovernmental Personnel Act appointments to include technical personnel from the commercial sector.

(U) **Other Program Funding Summary Cost**: N/A

(U) **Schedule Profile**: N/A

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
SUMMARY OF FUNDS BUDGETED FOR ENVIRONMENTAL PROJECTS
FY 1998/1999 PRESIDENT'S BUDGET

($ in Thousands)

Environmental Security Technology			FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	Change FY 97/98	Change FY 98/99
Cleanup	Not Applicable							
Compliance	Not Applicable							
Conservation	Not Applicable							
Pollution Prevention								
Appropriation:	RDT&E Defensewide							
		Environmental Super Critical Water Oxidation	5,570	6,631			-6,631	
		Joint Casting Emissions Reduction	3,900					
		Thin Film Coatings	3,558	3,255	3,768	2,190	513	-1,578
		Deep Ocean Relocation	2,446					
		CFC Free Manufacturing (SEMATECH)	8,500					
		Environmental Sensors	4,581					
	Grand Total		28,555	9,886	3,768	2,190	-6,118	-1,578

Justification for Changes The outyear funding changes reflect contractual requirements.

Exhibit PB-28